LECTURES

ON

SURGERY

BY JAMES SPENCE, F.R.S.E.,

SURGEON TO THE QUEEN IN SCOTLAND; PROFESSOR OF SURGERY IN THE UNIVERSITY OF EDINBURGH; LATE PRESIDENT OF THE ROYAL COLLEGE OF SURGEONS, EDINBURGH; SURGEON TO THE ROYAL INFIRMARY AND LOCK HOSPITAL; CONSULTING SURGEON TO THE ROYAL HOSPITAL FOR SICK CHILDREN, EDINBURGH, ETC. ETC.

PART II.

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NOTE.

The First Part of the Work, already published, was devoted to the special forms of Diseased Action and External Injuries.

The Second Part, now appearing, contains the Diseases and Injuries of Special Structures.

The Third and Concluding Part, to be published early in the present Session, will embrace the subjects of Special Operations and Regional Surgery.

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Fig. 2. Dislocation into the ischiatic notch.

Fig. 3. Dislocation on the pubis.

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HÆMOSTATICS—EFFECTS OF LIGATURE.—
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(*From nature by* John Wintour.)

Fig. 1. Right common carotid artery of a dog, forty-eight hours after the application of a small round ligature. The artery and vagus nerve are imbedded in a mass of plastic exudation. A portion of this has been dissected off at one part, to show a deeper layer of plastic material adherent to the external surface of the artery, and covering in the ligature.

Fig. 2. The same artery opened. This exhibits the relations of the changes induced by the ligature on interior and exterior of the vessel. The section of the deligated point shows the circle of the ligature embedded in lymph. Above and below this the divided coats are seen to be united by plastic matter. On the proximal side of the ligature a considerable blood-clot has formed ; on the distal side two small decolorised clots. The relations and attachments of the deep layer of the external exudation are well shown. The section shows the lymph to be closely adherent to the exterior of the artery, forming a continuous layer from below to above the deligated point, and bulging into the hollow formed by the constriction of the ligature.

Fig. 3. Appearances presented ninety-six hours after application of the ligature. The mass of plastic material on the exterior of the vessel is diminished in bulk, but firmer and more highly organised than in the Figures 1 and 2.

Fig. 4. Same artery opened. A very large blood-clot is seen on the proximal side of the ligature ; a smaller conical clot on the distal. The point of the vessel embraced by the ligature is beginning to undergo destructive changes ; it has a contracted and withered appearance. The deep layer of the external lymph has assumed a firm filamentous or membranous structure, and is seen connecting the ends of the vessel above and below the point of deligation.

Fig. 5. Carotid artery of a dog nine days after the application of the ligature, which was in the act of separating. The external plastic exudation was firmly consolidated around the artery, projecting into the groove formed by the ligature, and filling up the space from which the thread had passed, thus commencing re-union of the divided ends of the vessel. The knot of the ligature was contained in a cup-like cavity or cyst of lymph, and its ends were enveloped in a tubular prolongation of lymph, extending from the vessel to the external wound.

Fig. 6. Section of the same artery, exhibiting the relations and connections of the external and internal plastic exudation and of

the clots. The ligature had just separated, and was lying loose in the little cup-like cavity formed by the lymph. The lymph immediately around the knot was somewhat softer than the rest, but there was no appearance of purulent matter. The external exudation had followed in the track of the ligature, filled up the parts it had divided, come in contact with the internal plastic lymph, and thus the divided ends of the artery were re-united. The blood-clots were only firmly adherent at their bases.

Fig. 7. Artery thirteen days after the separation of the ligature. The point which had been tied is seen enveloped by a firm mass of consolidated lymph, which has united the separated ends of the vessel.

Fig. 8. Section of the same artery. Exhibits the connections and structure of the plastic exudation at the seat of ligature. There were no clots on either side of the deligated point in this case. The section of the consolidated lymph shows that the external and internal plastic exudations have coalesced so as to form a firm uniting structure of a fibrous character, and possessing a considerable amount of elasticity, as was proved by stretching the vessel.

PLATE XXII.—Page 510.

(*From nature by* JOHN WINTOUR.)

Fig. 1. Carotid artery of a large dog, sixty hours after deligation. The coats of the artery and the ligature are seen imbedded in plastic lymph. The vessels having been injected with coloured size, the external plastic mass is seen to be highly vascularised even at that early period.

Fig. 2. The same artery opened, to show the internal changes and their relation to the external lymph. (See page 510.)

Fig. 3 exhibits a partial section of a carotid artery twelve days after deligation ; the ligature had separated four days previously. On clearing the artery from the surrounding parts, and making a section of the lymph connecting the ends of the artery, and also of the distal portion of the vessel, so as to show the relations of the external and internal changes induced by the ligature, the arterial parietes were seen covered with a network of minute vessels. The section of the lymph, between the divided ends of the vessel, exhibited a vessel of considerable size passing upwards through its centre into the internal plastic lymph, and also into the base of the blood-clot. (See page 515.)

Figs. 4 and 5. The carotid artery of a dog. The ligature had separated without any hæmorrhage. The external appearances, as shown in Fig. 4, presented the usual appearances of solid exudation round the deligated part of the vessel. On making a section of the vessel and plastic lymph, the appearances delineated in

Fig. 5 were seen. On the proximal side of the ligatured part the internal adhesions had given way, and the blood-clot was partially extruded from the canal ; but the mass of consolidated lymph had prevented its further displacement, and so obviated secondary hæmorrhage. (See page 511.)

Fig. 6. Section of the femoral artery of a large dog, seventeen days after the ligature had been applied, showing the relation between the internal plastic coagulum and the blood-clot, as described at page 507.

PLATE XXIII.—Page 528.

Fig. 1. Femoral artery, eight weeks after amputation. The stump had healed. There is no vestige of a clot. The artery is diminished in calibre at the point of ligature, and a mass of consolidated lymph is seen surrounding and occluding its extremity. (From nature by John Wintour.)

Fig. 2. Femoral artery, seven weeks after amputation. Its section shows a large blood-clot firmly adherent to the coats of the vessel. (From nature by John Wintour.)

Fig. 3. Carotid artery of a greyhound, injected minutely, dissected twelve weeks after ligature. Shows the vascularity of the fibrous cord uniting the divided ends of the vessel, and also the true relation and connections of what are sometimes supposed to be new vessels. (See page 522. From nature by John Wintour.)

Figs. 4 and 5 exhibit the effects produced by torsion by Amussat's method (from Manec).

Fig. 6. The effects of accidental torsion on the brachial artery. The internal tunics are seen retracted and puckered inwards. The external coat is torn and twisted, and infiltrated with blood ; whilst immediately below the retracted internal coats a large blood-clot has formed. (See page 478. From nature by Mr. Livesay.)

Fig. 7. Brachial artery from a stump, thirty-six hours after the application of acupressure. The preparation is alluded to and described at page 530. The coats of the artery below the point where the needle had been applied are everted and thickened. Above, the interior exhibits a delicate and slightly adherent blood-clot. From the base of the blood-clot downwards the canal of the artery was plugged with firmly adherent lymph. The coats of the vessel have been opened and separated at one point to show the lymph filling up the vessel. The coats presented no appearance of injury by the needle. (From nature by Mr. Abercromby.)

PLATE XXIV.—Page 544.

Fig. 1. Sacculated popliteal aneurism after ligature. The sac, which projected forward towards the femur, is seen filled with strata of

consolidated coagula. The patient died of delirium tremens about five weeks after the operation. (From nature by Mr. Livesay.)

Fig. 2. Saccular aneurism of the innominate artery, showing the natural curative process. The sac is filled with strata of coagula, consolidated except at one part corresponding to the origin of the vessel from the aorta. At this point the disturbing force of the cardiac circulation has prevented the consolidation of the blood. A section of the wall of the aorta has been made to show the origin of the aneurism fully. (Mr. Livesay.)

Fig. 3. Dissecting aneurism. A rent of the internal tunics is seen in the ascending aorta, which is dilated just below the origin of the innominata. The blood has been propelled through this so as to dissect the coats from each other upwards along the innominate and also along the descending aorta.

Fig. 4. Fusiform aneurism of the axillary artery. This is a specimen of the "true aneurism of Scarpa," formed by dilatation of all the arterial tunics at the affected part.

Fig. 5. Dissecting aneurism of the common iliac artery. This occurred in a patient affected with senile gangrene. The vessels of the lower extremity were obstructed, as seen in the sketch ; and, under an excited state of the circulation, the blood seems to have been forced backwards, so as to dissect the internal tunics from the external coat in a direction towards the heart.

Plate XXV.—Page 558.

Figures 1 and 2 exhibit the operation for false aneurism at the bend of the arm, as described at page 559.

Fig. 1 shows the tourniquet applied to control the circulation, and the first incision through the integuments and superficial fascia. The deep fascia, distended by coagula, is seen bulging forwards in the wound.

Fig. 2. Wound after the clots have been cleared out. The opening in the artery is shown, with the ligatures placed one above the other below the wounded point.

Fig. 3. Appearance of the thigh of Mr. K—— 14 months after the operation for traumatic varicose aneurism. The small white cross marks the cicatrix of the original wound, and to the inner side the long cicatrix of the operation-wound is seen, marked by dilated superficial veins ; these are somewhat exaggerated in the sketch to make them distinct. See Clinical Cases.

Plate XXVI.—Page 576.

Fig. 1. Sketch of a case of femoral aneurism at the upper part of Hunter's canal, cured by ligature of the superficial femoral artery.—Case of W— W— ; see Clinical Cases of Aneurism.

Figures 2, 3, 4, and 5, exhibit different forms of apparatus for the treatment of aneurism by compression.

Fig. 2. Carte's compressor, used to compress the common, femoral, or external iliac arteries. In the apparatus shown, the ordinary compressing pad has been removed, and a rounded leaden weight substituted.

Fig. 3. Carte's compressor for the femoral in the thigh.

Fig. 4. Hoey's compressor.

Fig. 5. Compressor used successfully by Dr. Watson in three cases of aneurism. The apparatus consists of a splint, to which is attached a jointed and hinged metallic arc, provided with universal joint for supporting and directing the metallic rod, upon which slides the leaden elliptical weight by which the compression of the main trunk is effected.—*Edin. Med. Journal*, May 1869.

Plate XI

Fig. 1

Fig. 3

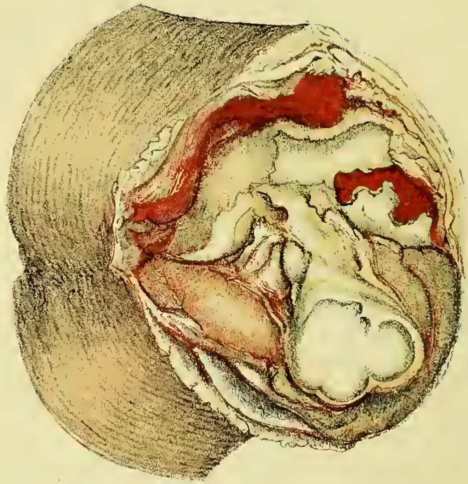


Fig. 2

Fig. 4

Waterston & Son, Edin. Lith.

INJURIES & DISEASES OF SPECIAL ORGANS.

DISEASES OF BONES AND JOINTS.

LECTURE XXXV.

Diseases of Bone, their Nature and Modifications—Explanatory Sketch of the Anatomical Structure of Bone, viewed in relation to its Pathology—Acute Ostitis and Periostitis—Local and Constitutional Symptoms and Complications.

In bone, as in all other tissues, diseased action is modified by texture.

The short and flat bones of the body—excepting those of the cranium—are composed chiefly of cancellated texture, enclosed in a thin fibrous shell. They therefore, as well as the articular extremities of long bones—on account of their loose structure—undergo morbid changes, somewhat analogous to those of the soft tissues.

The cranial bones have a very dense table internally, a tolerably dense one externally, and an intermediate medullary and vascular structure, the diploë. These therefore closely resemble the long bones as regards their anatomical structure and pathological changes.

The shaft of a long bone is composed of a very hard fibrous structure externally, which encloses a tubular cavity termed the medullary canal. On the exterior of such a bone we observe a number of small grooves or lines. If we look with a low magnifying power at a section of it, these broken lines are seen to be the oblique openings through which vessels pass from the periosteal surface into the dense texture of the bone. This dense texture of the shaft is very complex. In it are seen the Haversian canals conveying blood-vessels; and also canaliculi, which serve to convey the blood-plasma to the lacunæ. This structure is

evidently intended for the nutrition of the dense portion of the bone, and the cell-textures there have the power of attracting and assimilating that part of the blood required for their nutrition. In the ossified texture this could not be effected without the agency of such canals, and the canaliculi are for the purpose of allowing the blood plasma to reach the corpuscular portion of the bone. The medullary canal in the recent state is full of a sort of cancellated texture, with large vessels ramifying through it. This is the medullary Haversian structure; it contains arteries and large veins and the medulla or marrow; this is continuous above and below, with the finer cancellated texture at the upper and lower extremities of the bone. The vascular supply of this central part of the bone is different from that of the hard portion, which latter is supplied by vessels from the periosteum which pass into the Haversian canals. The Haversian structure of the medullary canal is supplied by certain large nutrient arteries, as they are termed, which pass through special foramina in the bone directly into the medullary cavity. These nutrient arteries ramify in the medullary Haversian structure, and anastomose with the vessels supplying the dense part of the bone.

The epiphyses of the bones are developed separately from the shaft, and are supplied by numerous vessels passing directly into them. Thus the shaft of the bone has two great sources of supply—one from the periosteum, the vessels of which ramify in the dense external structure, the other from the interior by the nutritious artery passing directly through the bone, and breaking up into branches in the interior of the medullary canal. The Haversian canals, though they are intended and serve to convey blood-vessels into the dense texture of the bone, have other uses. Each canal is lined with a thin delicate membrane, containing in it germinal cells. This, as pointed out by Goodsir, is in reality the formative portion of the bone. Its cells attract materials from the blood, and assimilate them for nutrition.

The periosteum invests the whole shaft of the bone as a distinct limiting vascular membrane, and allows the blood-vessels

to pass through it. At one time it was disputed whether the periosteum was a simple fibrous investing or a formative membrane. It is now known, from the researches of Ollier of Lyons, that it is a complex structure, consisting of the proper fibrous membrane, and a lining nucleated or germinal membrane continuous with that of the Haversian canals. This internal membrane assists in the formation of new bone, but the fibrous periosteum has no power of so doing. The direct experiments on living animals, which used to be considered conclusive as to the formative power of the periosteum, were complicated with so many sources of fallacy, inseparable from the operative procedure, as really to prove little more than the undisputed practical conclusion that, if we destroy the periosteum, we give rise to a want of nutrition and loss of reproductive power just in proportion to the destruction of the periosteum and vessels passing from it into the bone. Some of these sources of fallacy I may briefly mention, having tested them whilst planning a series of experiments which I contemplated, but abandoned as not likely to be satisfactory—1*st.* On the limbs of dead animals I found it impossible, even with the most careful manipulation, to separate the periosteum from the bone to any extent, without at the same time drawing out in connection with it the vessels and membranes from the Haversian canals, and hence, apart from what Ollier has since pointed out, I saw that there would always be some germinal structure from the lining of the Haversian canals removed along with the periosteum, and in the living animal this would serve to furnish new bone. 2*d.* When the periosteum was separated, and an inch or two of bone resected and removed, leaving the periosteum; besides the source of nutrition above mentioned, the sheath of periosteum left, acted as a mechanical means of keeping up the continuity between the ends of the divided bone, and prevented other structures intervening. Whilst when the periosteum was removed along with the bone, the divided ends were left loose and without any bond of continuity, and the muscles and other tissues around bulged into the intervening space in such a manner as would prevent

all chance of union. So that there was nothing wonderful in the fact that in the latter case the bone should not unite. It was quite impossible it could do so. In some of Mr. Syme's experiments portions of tinfoil were placed between the periosteum and the bone, and it was found that new bone was thrown out between the tinfoil and the periosteum, but I know of no experiment showing it to be formed on the exterior of the fibrous periosteum. I believe therefore that the internal lamina of the periosteum, together with the lining membrane of the Haversian canals, are the only formative textures engaged in the nutrition and reproduction of bone.

In the shorter bones, and in the cancellated texture of the epiphyses of long bones, the osseous structure is looser, yields more readily, and so allows changes to take place without so much destruction as in the denser texture of the shaft. In the shaft of a long bone the veins are not large in proportion to the arteries, the returning circulation being principally carried on by large veins which pass out from the neighbourhood of the epiphyses.

Keeping these structural peculiarities in view, let us now proceed to consider the diseased conditions affecting bone. Like every other texture, it is subject to inflammatory action; and you will easily understand, from what has been said, that the symptoms will be very intense, and the effects destructive. In inflammation of the soft parts the pain and risk are always less in proportion as the vessels can relieve themselves easily by effusion or exudation into the loose tissue of the part. The denser the texture, therefore, the greater are the destructive effects, and the more severe are the general and local symptoms. Whilst the soft tissues open out and allow a more healthy action to take place, dense textures, such as tendons and fasciæ, slough. They possess less vitality, and a comparatively small amount of exudation poured out into their structure produces destructive effects, and intense pain from the greater pressure on the nerves. When bone is inflamed all these conditions are at the maximum. Inflammation of bone may be either

acute or *chronic*. The former runs its course very rapidly, and from its usually destructive termination is sometimes spoken of as acute *necrosis*, or acute death of the bone.

An attempt has been made to distinguish between inflammation of the periosteum and of the bone proper, but in truth we cannot have the one without the other, owing to the close vital connection between them. The causes of inflammation of bone must be taken into account. These are either predisposing or exciting. The former are of two kinds principally—the strumous and the rheumatic diatheses—and superadded to these, accidental or adventitious predisposing causes, such as a syphilitic taint, or the long-continued use of mercury, or working among mercurials. The latter or exciting causes are exposure to cold or damp, or direct injury of the bone, leading to inflammation.

The most ordinary exciting causes of idiopathic inflammation of bone and periosteum are exposure to cold and damp in persons of strumous or rheumatic diathesis. The acute form occurs more frequently in the strumous than in the rheumatic, and generally in the young.

The symptoms of a typical case of acute ostitis are the following. The patient first feels pain in the bone of a very intense somewhat rheumatic character. This gradually increases. He becomes feverish, and has a slight rigor. The skin becomes hot, the pulse quick, and the intensity of the pain prevents the patient from getting any sleep at night. There may be no swelling of the limb noticeable, unless the bone be very superficial, nor is there much redness of the skin. The pain is felt along the course of the bone, and the disease, in this stage, is sometimes mistaken for neuralgia, and treated accordingly. The local symptoms and the symptomatic fever increase; the pulse becomes very quick, hard, and wiry; the tongue foul and furred. The pain is exacerbated whenever the patient takes any warm food. Redness and swelling now make their appearance over the bone, and the limb soon assumes the characters of erysipelas. The case may now be mistaken for one of acute

phlegmonous erysipelas, and leeches are perhaps applied with some temporary benefit, or punctures or incisions are made with still greater benefit, or opiates may be given, and the patient obtains some rest. But the relief is only temporary; the pain returns; the fever alters in character; indeed, there is a great tendency for it to assume an irritative type from the first. The pulse becomes rapid and irritable; the tongue red and glazed at the edges, with a dry centre; and there is delirium at night. The secretions are arrested. The irritative fever sometimes succeeds on the symptomatic within forty-eight hours. These conditions used to be attributed to the erysipelas having led to disease of the bone, but they are really due to acute periostitis and ostitis, the surface being affected secondarily from the inflamed bone. In such cases the periosteum is found very much thickened, and instead of presenting the usual thin appearance, it has become fleshy and highly vascular; and where it has given way, the bone is exposed—bare, white, dense, and smooth—with hardly any change in its structure; the diseased action having been too rapid to allow the dense portion to open out.* In the chronic form of inflammation time is generally afforded for the dense texture to open out, and for the vascular canals to dilate in proportion to the distension of the vessels, but in acute ostitis the action is too rapid for this; the exudation poured out blocks up the Haversian structure, and canaliculi circulation and nutrition are arrested, and complete death of the part ensues. The denser structure of the bone does not allow of the vessels relieving themselves as in softer tissues, and the texture dies from the pressure of the exudation. The secondary effects, the redness and tense swelling, and acute œdema, arise from the vessels of the periosteum and of the soft parts becoming implicated, and the inflammation then assumes the erysipelatous character. When the inflamed bone is deeply seated, like the femur, there is not generally at first much, if any, tension of the limb, and the cause of this should be understood. Between the deeply-seated bone and the skin are very dense

* See Plate xi. Fig. 1.

resisting textures. First, the effusion takes place into the loose tissue between the femur and the quadriceps extensor femoris, and is so limited. Next, the strong fascial textures resist the exudation from the vessels, which gradually relieve themselves into the loose cellular tissue between the skin and fascia, and then the acute œdema supervenes long before there is any marked tension. In some cases, if the diseased action be not so severe, and if the patient be tolerably healthy—of the rheumatic rather than the strumous diathesis—the rapid death of the part may not take place, but the exudation will be poured out into the soft parts, and between the bone and the periosteum, where it can be more easily effused. This will give rise to alteration on the surface of the bone, and when the excited action has been subdued, its effects are seen in a deposition of new bone on the surface, as in the specimens before you.

Where the diseased action goes on more slowly, the morbid changes also take place in a modified form. The inflammation affects different parts of the bone, which becomes irregularly shaped from the deposition of new osseous matter here and there. It may even be deposited in the interior, so that the bone becomes solid.

In very acute cases, the death of the bone may take place through nearly its whole extent, but this is very rare, and strictly speaking never occurs, for there are always certain portions separated along with the periosteum, leaving nuclei for the formation of new bone.*

Such are the symptoms of acute periostitis and ostitis. We should bear in mind that, in scrofulous patients especially, the fever which supervenes upon the symptomatic is almost constantly of the irritative type, and frequently complicated with diseases of other organs, especially of the kidneys and pericardium.

* See Plate xii. Fig. 2.

LECTURE XXXVI.

Chronic Periostitis and Ostitis—Symptoms, Progress, and Pathology—Natural and morbid terminations, as Resolution, Suppuration, and Necrosis—Treatment of Acute and Chronic Periostitis and Ostitis—Of Necrosis and Suppuration of Bone.

THE symptoms of Chronic periostitis and ostitis are much the same as those of the acute form of inflammation of bone. They are slower in progress, and are otherwise slightly modified by the diseased action being less violent. There is generally a good deal of dull aching pain in the part, attended with a feeling of tension. This pain is always deep-seated and more localised, not so much diffused, as in acute ostitis. Every now and then there is an exacerbation of the disease. All the symptoms become more intense at these times, and then the pain, tension, and other symptoms, are very similar to those of the acute form. The febrile symptoms are not so intense in chronic periostitis, for though sometimes there is a good deal of symptomatic or irritative fever, there is almost never the great constitutional disturbance which attends the acute inflammation of bone. There are two circumstances which mark the peculiarity of the inflammation of the osseous texture both in the acute and chronic forms—namely, the exacerbation of the pain, which comes on whenever the patient gets warm in bed, and a similar result after he takes food. This symptom is the result of the excited circulation, and consequent distension of the bloodvessels in the unyielding texture of the bone. Both acute and chronic ostitis frequently terminate in necrosis. In the chronic form there is more time for the dense osseous texture to open out and allow the congested vessels to relieve themselves, and the diseased condition is thus so far modified.

In a bone affected with chronic inflammation, the Haversian

canals are much larger and more opened out than normally ; the dense texture of the bone is also lighter than usual. It becomes granular and spongy, and approaches in character the cancellated texture, though afterwards it becomes consolidated, when the diseased action goes on longer. There is often also a nodulated condition of the bone from the deposition of new osseous matter on the surface. The enlarged Haversian canals can then admit vessels of a very considerable size, which are able to relieve themselves of their serous or plastic contents, and the symptoms of the disease are therefore rendered less intense ; but as in all other forms of chronic inflammation, the exudation tends to produce organic changes. A larger amount of nutrition goes on than natural ; and at last the exudation becomes consolidated, till the canal of the bone may be entirely closed, and in some cases become positively solid. The bone is thus enormously thickened and irregular ; but when the diseased action ceases, gradual absorption takes place, and the bone tends to regain its normal form. Nodes, or masses of new bone, often form in the ostitis of syphilitic patients ; they are also met with occasionally in those of a rheumatic diathesis. In all cases of disease of bone, and of the periosteum perhaps more than the bone itself, there is a tendency for other fibrous textures to become affected secondarily. Of these the fibrous pericardium is that most generally attacked, especially in the acute form of periostitis, in patients of a rheumatic diathesis ; and we should carefully watch for this dangerous complication.

The terminations of inflammation of bone are various. The most favourable is resolution, in which the inflammation subsides, and the bone resumes gradually its normal character and type. In some cases there remains the deposition of new matter, forming irregularities or nodes on the bone.

Another termination of the disease is Suppuration. This occurs in two forms—1st, Subperiosteal. An abscess may form between the bone and the periosteum. This result generally occurs after chronic periostitis in patients of an unhealthy constitution. There is slight redness, swelling, pain,

and a feeling of fluctuation after a time, though it is only imperfect. It occurs principally towards the centre; there is some elasticity also towards the sides and base. The swelling may be pretty large, and yet contain very little purulent matter. On opening such an abscess we find a small quantity of greyish unhealthy-looking pus; part of it is a sort of gelatinous mass, and the rest looks like unhealthy serum. When we examine the fluid part we find pus-cells in it, but they are small and very imperfect, and there is a quantity of molecular debris mixed up with it. After opening the collection we find that the wound does not heal well, and it is this form of abscess which experience warns us against opening. As a result of acute periostitis we also often find pus forming in the soft parts around the bone, in consequence of the irritation produced by the inflammation; but in these cases the pus is generally healthy, and requires speedy evacuation. This is quite different from true periosteal abscess, which is a collection of ill-matured purulent fluid and aplastic exudation between the periosteum and the surface of the bone.

2d. An abscess may form in the interior of the bone itself. In the substance of the cancellated texture and condyloid portions of bones in the neighbourhood of joints, abscesses often form with a distinct pyogenic membrane, the cavity of the bone being hollowed out, so that when the bone is cut into there is a gush of matter from the osseous texture. In bones like the os calcis they may also form and discharge themselves by destroying the thin shell of the bone, the cancellated texture allowing suppuration to take place much more readily than the denser texture would. Hence in the articular ends of bone suppuration is much more likely to take place than in the denser osseous structure, where the same amount of irritation would probably lead to necrosis. In bones of a denser character, as in the lower jaw, abscesses sometimes form, and the bone is often very much thickened. In such cases we find that matter has formed at one point within the dental canal of the bone—which is partly composed of cancellated texture—and that its pressure has bulged the bone out-

wards. Sometimes there is thinning of the bone, as in the cystic tumour, or spina ventosa; but the true abscess of bone is generally attended with great thickening, not thinning of the walls. It generally occurs in the cancellated texture, though it sometimes forms in the shaft of the bone. In the latter it never produces a very large abscess, because the whole bone becomes inflamed, thickened, and condensed. The patient feels the pain excessively severe and persistent, but localised to one point. There are rigors and other symptoms of suppuration, preceded by severe symptomatic fever, and intensified when the suppuration does occur. The symptoms are intensified here by the increased pressure produced by the pus developed in the dense unyielding tissue. When such an abscess forms, the medullary canal of the bone is not pervious throughout. There is a little bulging in front corresponding to what seems to be a node. The bone is much condensed in circumference, and the medullary canal is closed up by the exudation becoming ossified. There is thus a circumscribed abscess shut in on every side by unyielding texture. The pain and other symptoms are therefore very severe, and the diagnosis is very difficult, for it is almost impossible to say whether matter has formed. The localised pain, the rigors, and slight bulging give us some indications of an abscess having formed; but the absolute diagnosis by the feeling of fluctuation is out of the question, for it could not be felt through the dense structure of bone. Even in the lower jaw there is great difficulty in the diagnosis, and sometimes the jaw has been removed under the belief that the swelling was due to a tumour, and not to an abscess. We should take the precaution of passing a trocar or a perforator through the alveolar process to see if there be any pus.

We shall now proceed to consider the treatment of acute and chronic periostitis and ostitis, and suppuration of bone.

In acute periostitis and ostitis a good deal depends on the conditions accompanying the inflammation — the state of the patient, and whether he be of a rheumatic or strumous diathesis. This form of the affection may supervene after debilitating dis-

ease, such as fever, or by exposure to cold. In such cases the patient is much weakened before the diseased action comes on, and this will modify the symptoms. In a typical case, when the acute inflammation has come on suddenly, with rigors and violent symptomatic fever, without much apparent swelling or discoloration, the first thing to do is to enjoin absolute rest of the limb, which should be perhaps somewhat elevated, the muscles being relaxed as much as possible. If the bone be deeply covered, leeches followed by warm fomentations may be applied to the part, so as to relieve congestion and relax tension by depleting the superficial vessels. The bowels should be freely opened, and opiates given to procure rest at night, combined with some medicine, such as ipecacuan or guaiac, to determine towards the skin and restore its secretion. Gentle diuretics may also be given to act on the kidney. In most cases, however, these means are insufficient for relieving the symptoms. If the bone lie near the surface, like the tibia, and this is the bone most generally affected with acute periostitis, our measures must be more active. When redness and tension come on, as they very soon do, then free incisions should be made down to the periosteum. Sometimes even cutting through the periosteum will afford great relief, by allowing exudation to escape, and thereby preventing pressure. A mere linear incision will not necessarily lead to necrosis; it will in many cases prevent that result. After making the incisions, warm or anodyne fomentations should be applied; they will afford great relief to the patient. The symptomatic fever will thus be relieved, and the irritative fever prevented, or at least modified in character. The incisions always bleed smartly at the time; but we need not be afraid of dangerous hæmorrhage taking place—the loss of a little blood in fact does good. In cases, however, of acute periostitis after fever, we might hesitate to make incisions or punctures, or even to apply leeches, for fear of the bad effects of depletion on the patient when in an exhausted state. By delay in making the incisions, however, we keep up the debilitating cause and the irritation, and loss of sleep will do much more harm than the mere loss

of blood. A boy of twelve had an attack of scarlet fever, and this was followed by typhoid fever. While recovering from the latter he was seized with sudden pain in the leg. Opiates were given to procure rest; but the boy could take no food, and, when wine or other stimulants were given, the pain was increased. The case was supposed to be one of erythema; but on examining the patient I saw it was a case of acute inflammation of bone—the boy being of a strumous diathesis. Notwithstanding his debilitated state, I made free incisions through the periosteum of the tibia, and thus relieved the symptoms greatly. After this the patient began to take proper nourishment, and got rest at night. He was not allowed to lose much blood, and recovered rapidly, without any exfoliation of bone or other bad symptom. This patient was very debilitated when the incisions were made, but had this not been done, he would have suffered much more, and would probably have died from the febrile excitement attending the disease. This is an example of the proper treatment, and is an encouragement to proceed to active measures even under what seems to be most unfavourable circumstances, for by so doing we are much more likely to prevent necrosis, and we certainly relieve the patient's sufferings.

We do not require to adopt this treatment in all cases. When the tension is not so great, or when the bone is deeply seated, like the femur, it is not necessary at once to cut through all the muscular substance of the limb, for that would cause great risk of itself. In such cases warm fomentations may be applied, and depletion by leeches or cupping will be of service. When the patient is of the rheumatic diathesis, certain remedies are found to be very beneficial, such as ipecacuan with opium, or extract of colchicum, with a slight purgative, if necessary, especially in the chronic or sub-acute form of inflammation. In some cases the tincture of aconite, in small doses, will afford relief, but I have not the same faith in it as in colchicum. In chronic arthritic cases especially, the use of the bromide of potassium, in doses of 10 to 30 grains, or even more, will greatly allay the irritability of the constitution. The iodide of potassium is

a remedy to which we trust much in the more chronic forms of inflammation, especially when we suspect any syphilitic taint—also in scrofulous cases; but it is of no use in the acute stage. When we want to get rid of some of the organic changes which have taken place—deposits between the bone and the periosteum—or, when the pain is probably caused by the exudation thrown out still remaining, the iodide of potassium, in 5-grain doses, twice or thrice a-day, will be found a very valuable remedy. In other cases belladonna may be applied on the surface, to relax the parts and relieve the pain; but this is merely a local anodyne application. As regards depletion in chronic periostitis, cupping or incisions are the best methods of effecting it; a soft poultice should then be applied to the part. Great care should be taken not to expose the patient to cold while cupping or leeching, as that will certainly do harm, and only a moderate quantity of blood should be abstracted.

In cases of abscess in the cancellated texture of a bone, when it does not communicate with a joint, if there be much tension, an incision should be made into it and a poultice applied to favour the escape of matter. Abscesses external to the bone must of course be opened at once, and the ordinary treatment of acute abscess adopted. In abscess in the cavity of a long bone, where there is a great difficulty in the diagnosis, Sir Benjamin Brodie proposed trepanning, which is the proper treatment when we are certain of the disease, as it will at once get rid of all the excessively painful symptoms, and prevent further mischief, and even though no matter has formed the patient experiences great relief from the operation. In one case in which I was consulted, I found that, after an attack of subacute periostitis, there was enormous thickening of the limb, the pain was intense and localised, there were repeated rigors, and the patient's health was failing. Trepanning was performed under the belief that an abscess had formed in the bone, but no pus was found. A good deal of bleeding took place, but from the time the operation was performed the man began to recover, and was soon perfectly well. Thus in some cases, when the symp-

toms are very severe, we may trepan, though the diagnosis be doubtful, for even if there be no matter little harm is done, and much good may result from the relief of tension.

In the true chronic periosteal abscess we should not open the abscess unless the case has advanced very far before we see it. Whilst there is still a good deal of thickness covering the parts, and when there is merely a pinkish blush on the surface, a blister should be applied over the abscess, and afterwards the part dressed with warm water lint. Under this treatment the swelling gradually becomes less and the matter is absorbed. I do not believe in any great absorption of purulent matter, but certainly in this form of abscess it does occur, for I have seen many cases of periosteal abscess disappear under the action of a blister, and the use of iodide of potassium. In these cases there is an alteration in the constitution of the secretions, such as the urine, showing that some organic matters are being eliminated. Such an abscess should certainly never be opened until we cannot possibly help it. If the abscess bursts, the opening should be enlarged to allow the free escape of the matter. If we do open the abscess, we find that the edges of the wound become everted, the gelatinous mass which forms the principal part of the collection becomes sloughy, the surface of the bone becomes exposed and is rough, brown, and granular, not unlike what it is in caries or ulceration of bone. If the abscess opens itself, or if it has been opened, the opening should be enlarged so that the bone may be seen. A piece of lint covered with the powdered red oxide of mercury should then be applied on its surface. This acts as a stimulant without being a caustic, it destroys the vitality of the weak surface of the bone, which is thrown off as a granular discharge, and leaves a healthy surface below.

LECTURE XXXVII.

Ulceration of bone—Caries, definitions; pathological appearances; prognosis; treatment—Acute Curvature of the Spine, a result of deeply-seated Caries—Early manifestations and later symptoms of the disease—Treatment by constitutional measures; by mechanical appliances.

ULCERATION of bone may take place as a result of inflammation as in the softer tissues, but it is attended with peculiarities arising from the structure of bone, and from certain constitutional conditions under which it is most liable to occur.

The exudation thrown out in the dense texture of inflamed bone interferes with nutritive action, and hence, when ulceration of bone has taken place, even in its simplest form, the healing process is slower than in the softer tissues. In cases, however, where there is no constitutional predisposing cause, simple ulcer of bone heals favourably. For example, when, from some local injury, abrasion of the periosteum has occurred, followed by inflammation and superficial ulceration of the bone, or when chronic ulcer of the soft parts over a superficial bone, as the tibia, has led to ulceration—under proper treatment, as by simple water-dressing or some slightly stimulating lotion, in such cases the surface granulates, a fibrous texture covers it in, and the soft parts close over it by secondary union. Again, in cases where pressure from a tumour or aneurism has led to ulcerative absorption of neighbouring bone, the diseased action is arrested so soon as the pressure is removed; there being no special cause in the bone itself preventing the healing process. These may be taken as examples of simple ulceration of bone, and they should be carefully distinguished from the form of ulceration termed CARIES. Unfortunately, that term has been very indiscriminately applied to all ulceration of bone, without much regard to the pathological conditions; and some of

the definitions of the term would mislead us as to practice. Thus, Professor Syme says, "When the ulcer of the bone resists all means of cure, it constitutes what is called 'caries.' The distinguishing character of 'caries' is the same as that of cancerous ulcers—obstinacy of the disease." Now this is a very unfortunate definition, for the main character of cancer is wanting to complete the analogy. The great distinctive feature of cancer is not mere passive obstinacy of cure, but the aggressive destructive characteristic of malignancy—the tendency to involve all the neighbouring parts in the same diseased action. Mr. Liston used to define 'caries' as a low form of ulceration in bone; the part possessing an amount of vitality sufficient to prevent the affected surface being thrown off, but not having sufficient vitality to promote healthy action. This definition is nearer the truth, and is absolutely true at certain stages of the disease; but I believe that the peculiar obstinacy of a truly carious surface arises from the fact that a large part of it is really dead, and consequently requires to be removed by artificial or natural processes ere a cure can be effected. The older surgeons used to speak of moist and dry caries; the latter term denoting the more evident death of bone in sequestra or exfoliations—necrosis. For my own part, I would have little hesitation in defining the actually carious surface as molecular necrosis. You may remember that, when explaining the process of ulceration in the soft tissues, I stated that it was a form of chronic mortification of part of the affected tissue, that owing to the quantity, and also in many cases the quality, of the exudation thrown out, it interfered with nutrition, and prevented or delayed reparative action. Now, in a texture like bone, you will readily understand death of portions of the dense texture is still more likely to occur; and in the looser cancellated bones, the dead portions are generally granular instead of separating readily in masses; in fact, that the form of death is determined or modified by the character of the texture in which this diseased action is situated, and hence the condition termed caries is almost confined to the short or flat bones, or to the articular

extremities of the long bones—in a word, to the cancellated texture.

In Caries the portion affected presents to the naked eye a granular or reticular appearance, of a brown colour; the part affected is greater in superficial extent than depth, and the surface is softer than natural—rotten as it were—so that a probe passes into its substance without any pressure being used.* The surrounding soft parts are swollen and irritable, with sinuses leading to the diseased bone, or thickened, with everted edges and pulpy projecting flabby granulations. I have said the surface is of a brown colour, and granular in appearance; but when a portion of bone so affected is removed and carefully macerated, then, when we examine it with a low magnifying power, we see that the granular appearance is due to minute white short hair-like spiculæ, projecting from or lying on the surface. A deeper section will show further changes in the bone beyond, which explain the low form of action and difficulties of repair characterising caries. The alterations of texture beyond the carious surface to which I allude exist in two different forms. *First,* as we often see in the bones of the tarsus, the texture is opened out, and the enlarged cancelli are filled with altered medulla, or rather a lardaceous substance, varying in colour from a pale yellow to a dark reddish-brown or purple; and not unfrequently in certain bones, as the head of the tibia and the bones forming the elbow-joint, the cancellated structure is loaded with tubercular looking matter. The *second* condition is one more apt to be overlooked, but one which, if possible, shows greater alteration of natural structure. It is a condition the very opposite of the former, and consists in a peculiar condensation of the bone beyond the carious surface. It was first described in relation to dental caries by Mr. Nasmyth of this city; and the late Professor Goodsir has very well described it in the caries of ordinary bone. "In true caries," says he, "for a certain depth below the surface of the affected part, the corpuscles and canaliculi have

* Plate xii. Fig. 4.

more or less completely disappeared, so that the subjacent unaltered osseous structure is covered in by a layer of apparently solid bone, resembling marble, and analogous too in some respects to the enamel of the teeth, amongst others in being incapable of absorption, and hence requiring either to exfoliate or to be removed artificially."* Now the first of these conditions shows a peculiar deposit infiltrating the cancellated texture, lowering its vitality, and predisposing it to an unhealthy form of ulceration. The second—the peculiar condensation of the bone underlying the carious surface—forms a barrier to the vascular supply necessary to support due vitality, and prevents absorption of disintegrated texture. Beyond the condensed structure, however, healthy action goes on, as is evidenced by the active deposition of new bone in the vicinity of the carious surface. To understand the true pathology of caries, however, we must look beyond the local changes to the constitutional conditions which induce and modify them. The carious ulceration is the result of a low type of inflammation of bone which is met with in two constitutional conditions—the strumous and syphilitic. Now, in both scrofula and syphilis, we find a tendency to deposits of vitiated albumen taking place in certain tissues, and bone is frequently so affected. In fact the exudation thrown out by inflammation in scrofulous and syphilitic patients is aplastic, and not fitted for repair, having little or no tendency to be converted into permanent tissue, and so, besides its bulk and pressure, interfering with vascularisation of the part ; even when in small amount, it remains inert, difficult of absorption, unfit for repair, and chiefly got rid of by disintegration and discharge. It is this condition, depending on the constitution, that leads to the local changes, and which renders the diseases of bone in such patients so difficult of treatment. Indeed, the surrounding soft tissues in caries show the same tendency even after the diseased bone has been removed ; and it is all-important that we keep this in mind in reference to prognosis and treatment in cases of caries.

* See Plate xii. Fig. 3.

The progress of the local and constitutional symptoms in a case of caries may be briefly described. At first there is slight pain and indolent swelling in the neighbourhood of the diseased bone; gradually the deep-seated pain becomes more severe, the swelling becomes discoloured—of dark lake-colour, tense and shining or else boggy; at last pus forms, and is discharged either artificially or by ulceration. The pain is now somewhat relieved, but the swelling remains indolent. In some cases the openings which have discharged the pus close, except small pouting orifices, which continue to discharge their gleety and often very offensive matter.* When a probe is introduced into one of these openings, it comes in contact with the carious bone. In other cases, the openings of discharge extend by ulceration; the edges become infiltrated and everted; fungoid masses of unhealthy granulations occupy and project from the centre of the ulcer, and on destroying these, the carious bone can be seen, presenting the softened rotten surface of the dark-brown or purplish hue already mentioned. The severity of the pain and character of the inflammation which precede the suppuration and exposure of the caries are very variable. In some cases, as in articular caries, the pain is excessive, especially at night; and even in cases of caries of the tarsus or carpus, the pain and swelling are acute, but more usually the symptoms are such as I have described. The general health is often affected to a much greater degree than the local disease or amount of discharge from the surface or sinuses would account for; but then we must recollect that the disease is one of the manifestations of scrofula, and hence the hectic fever, constitutional irritation, and debility, which might, at first sight, seem to be out of proportion to the local cause. At the same time the caries is the exciting cause; and if the diseased portion of bone be removed, it is remarkable how rapidly the general and local conditions improve.

Keeping these things in mind, it is evident that our prognosis in caries must be favourable in proportion as the carious surface

* Plate xiii. Fig. 5.

is limited and can be reached, so as to enable us to remove it before the constitution is exhausted by long-continued irritation. Hence, in cases admitting of operative measures for removing the diseased parts by excision or amputation, our prognosis is favourable as to the result, unless other organs be affected, which unfortunately is sometimes the case. In cases where the diseased bone or bones are so situated that we cannot interfere to remove the carious surface—as, for example, in caries of the bodies of the vertebræ—it must be evident that the result is more doubtful; and when repeated formations of abscess and long-continued purulent discharge have exhausted the patient, the prognosis is very unfavourable. Even such cases, however, are not hopeless, nor do I consider that caries is incurable except by operation, as some surgeons state. No doubt, when we can reach and remove the disease early by operation—as I have already said, that gives a great advantage; but we must not conclude, on the other hand, that cases such as caries of the spine are hopeless. They are often brought to a successful issue by proper treatment hopefully persisted in. The idea of their incurability is often the cause of their not being cured, by leading to trifling and intermittent instead of energetic and persistent treatment.

The *Treatment* of caries in cases which admit of operation might be briefly summed up as consisting in the early removal by excision, gouging-out, or amputation of the affected part. In cases where that is impracticable, absolute rest to the affected part, the use of the actual cautery as a counter-irritant before suppuration has set in, and the exhibition of chalybeate tonics, cod-liver oil, and nourishing diet—careful attention being given to the state of the different secretions and excretions. It will be better, however, to take special cases of caries as illustrative of the treatment. Take, for example, a case of caries of the head and tuberosities of the humerus, where suppuration has taken place, and in which, through the opening of the abscess, we feel the bone bare. In such a case, so soon as the irritative fever had abated, I would proceed

to excise the diseased bone at the shoulder-joint, so as at once to remove the disease, and to obtain a more useful movable limb, than if the operation were delayed, and at the same time to relieve the constitution from the exciting cause of the exhausting discharge and hectic. The same rule applies with still greater force to the elbow and wrist joints. In the case of the knee-joint, the extent of disease and other conditions must make us weigh the comparative advantages of excision and amputation. Where one or more of the bones of the tarsus are affected by caries, the treatment will depend on circumstances. Thus, if the disease be confined, say, to one of the cuneiform bones on its upper surface, I would enlarge the opening leading to it, remove the exposed carious surface with the gouge, and when the oozing of blood had ceased, apply dilute nitric acid or finely-levigated red oxide of mercury to the surface to cause exfoliation or destruction of any doubtful structure which might be left. In many cases this suffices; the soft parts heal, and the cure is effected. In some cases I have excised one or more of the cuneiform bones, and also the cuboid bone entire, with success; but these are always tedious, difficult, and uncertain operations, and in some cases diseased action is set up in the foot leading to disastrous results. If the tarsus were pretty generally affected, I would amputate at the ankle-joint rather than leave the os calcis or astragalus, or any portion of them, as in such cases the risk of these bones assuming the diseased action is very great.

The foregoing are examples of cases in which the caries is so situated, that the surgeon can reach and deal directly with the diseased bone — cases, therefore, in which the treatment by operation or local applications constitutes the most evident indication, although constitutional measures are also important. As an example of the treatment of caries when so situated as to be out of reach of direct local interference, and as showing the curability of the disease even under such circumstances, let us take a case of caries of the bodies of the vertebræ.

This diseased condition, which in its advanced stages gives

rise to acute projection of the spinous processes of the vertebræ affected, or Acute Curvature of the Spine, has, from its true nature having been very accurately described by Pott, received the name of Pott's Curvature. Essentially it consists in carious or ulcerative absorption of the cancellated structure of the bodies of the vertebræ, with alteration and destruction of the inter-vertebral substance, or elastic fibro-cartilage, causing the bodies of the adjoining vertebræ to approach each other, and so gradually to project the spinous processes until the projection becomes acute. Long ere any projection is noticeable, however, the real disease is in action, and as it is in this early stage we have most hopes of doing good, I will briefly point out to you the progress of such a case.

Caries of the bodies of the vertebræ, like most manifestations of scrofula, is a disease of early life, usually beginning in childhood; and for a time the disease may, indeed generally does, advance without much pain or other marked symptom. The gait of the little patient, when walking, may attract attention. The head is carried erect and a little back, and the shoulders also seem carried well back, and as the child moves very circumspectly, it is sometimes noticed as having a "fine carriage." By-and-by the child is noticed to be very cautious in going down a stair, or any declivity, and to complain of pain in doing so, or after making any exertion. The general health now begins to suffer; there is heat of skin, restlessness and starting in sleep, and want of appetite. The patient cannot sit or stand long in the erect posture, and complains of pain at some part of the back. On examination there is a slight fulness observed at some point in the spinal region, and on pressure there the patient winces or screams. In most cases the abdomen is tumid, and the lower limbs wasted, and twitchings of the muscles of the limbs are noticed. If the spinal swelling be only slightly marked, and the pain not very severe on pressure on the spine, a very good method of diagnosis is to throw down some toy on the ground and bid the child pick it up. When the diseased condition is present, the child, instead of stooping in a

natural manner, gets down on its knees to pick up the object. The movement of stooping in this instance elicits the symptom of pain, and the child has instinctively learned to avoid that movement.

In some cases, in very young children, twitchings and loss of power in the lower limbs first attract attention—these symptoms in many cases depending not on any direct pressure on the spinal cord, but on indirect irritation from the contiguous disease. As the disease advances, the symptoms become unmistakeable, the spinous processes gradually become more and more prominent. These changes are attended by deep-seated pain and muscular twitching, and followed by gradual loss of regulating motor power. At length the curvature becomes very acute, and the stature of the patient is obviously diminished. After a time abscess forms, and the pus usually points outwards either in the lumbar or inguinal regions, constituting what is termed lumbar or psoas abscess. At this stage irritative or hectic symptoms supervene, and the patient may die from exhaustion, or the irritation caused by the carious bone may lead to inflammation and softening of the spinal marrow, or the cord may suffer from pressure caused by the absorption of the diseased bodies of the vertebræ, and the falling in and approximation of those above and below the disease. Then we have paralysis of the organs below the site of the affection, retention of urine with chronic cystitis, and loss of power in the sphincter ani. In such cases the irritation, after a time, is generally propagated upwards, and leads to a fatal issue.

The disease I have just described, arising from caries in the vicinity of an important vital organ, and so situated that the surgeon cannot reach it to remove the carious portion of bone by any operative procedure, is indeed an exceedingly dangerous disease, and would be utterly hopeless were the opinion correct that caries is only curable by excision of the diseased bone. In the latter or advanced stages, the disease is very hopeless; but if properly and energetically treated at the earlier stages, we can do much to alleviate and often to cure the

disease;—first, by allaying the deep-seated subacute inflammation of the bone, and so arresting the ulcerative process before much structure is implicated; next, by maintaining the parts as far as possible at perfect rest, and preventing the superincumbent weight of the head and trunk above the disease acting on the carious part of the vertebræ; and, at the same time, favouring the process of osseous or fibrous anchylosis.

To fulfil these indications, we at first direct that the child should be placed on a couch arranged on an inclined plane, and kept as much as possible in the prone position, so as to avoid all pressure on the spinous processes, and to take off the superincumbent weight from the diseased part of the spine. The prone couch, as it is called, is usually fitted with a little table or slab of wood projecting in front, on which the child's toys are placed, so as to induce it to remain in the prone posture. Of course the child, when at all free from pain, will not remain in one position, it will occasionally turn on its side; but the form of the couch prevents it resting on the back, which we principally wish to avoid. During this stage, great attention is requisite to regulate the bowels and to nourish the child by diet, cod-liver oil, and chalybeate tonics, and to afford it as far as possible the benefit of fresh air and passive exercise. With a view to the last-mentioned objects, the prone couch may be fitted with wheels, so that the patient can be moved about the room, or out into the open air when the weather permits. If there be much or persistent tenderness on pressure over the spine at the affected part, with, perhaps, slight puffy swelling, the actual cautery should at once be applied at a little distance from the diseased point, so as to create counter-irritation and establish an issue. The effect of the cautery is often marvellous in arresting the deep-seated pain and allaying the diseased action. And when the eschar separates, the surface is slow of healing, and so the discharge is kept up for some time, and thus diminishes the deep-seated action. There is no other form of counter-irritation or issue equal to it, in cases of diseased bone; and as we can put the child under chloroform, the pain of the application is

not felt. After the cautery has been applied, lint soaked in cold water, or a little weak aqua ammoniæ is used to allay the pain; then poultices are applied until the slough separates; subsequently, some slightly stimulating dressing—such as resinous ointment—is used to keep the sore open for some time. As I have already intimated, great care must be paid to the constitutional treatment, by attention to the state of the digestive organs, and by tonic and nutrient regimen and diet to invigorate the general health. After some time, varying from two to three months, if the pain and uneasiness have disappeared, we permit the patient to move about cautiously; but before doing so, a light spinal support, very carefully fitted, should be used, so as to prevent the weight of the part of the body above the disease pressing injuriously on the affected vertebræ. I am very averse to so-called "supports" in weak limbs or lateral curvatures as a general rule, but in this disease a well-made light support, resting on the pelvis and supporting the body by rests under the armpits, is essential to the treatment and admits of the patient using the lower limbs without risk.

In cases where suppuration has occurred before we see the patient, the cautery can hardly do much good. The abscess should be opened by the exhausting syringe, or with the trocar and canula with the tube under water, as described in the lecture on suppuration (page 30). If the suppuration diminishes, then the cautery may be of use; but, as I have already said, the chances of successful treatment at this stage are very small. All we can do is to maintain rest in the prone position, and try to keep up the patient's strength, in hopes of arresting the diseased action. I have taken this dangerous form of deep-seated caries as an example of the method or principles of treatment to be pursued in all cases in which the carious bone is beyond the reach of direct surgical interference.

LECTURE XXXVIII.

Necrosis, Idiopathic and Traumatic ; Acute and Chronic ; Superficial and Internal ; Partial and Complete—Outline of the changes and appearances observed at the different stages of the diseased action—Local and constitutional conditions which tend to modify that action—the Necrosis of scrofulous patients and its relation to Caries.

Necrosis, or death of bone, corresponds to mortification of the soft parts. It may result from external violence either destroying directly the life of the bone, as in some cases of fracture, especially gunshot fractures, or so injuring the surrounding textures, that the vitality of the bone is affected secondarily, and so impaired that portions of it die and exfoliate ; as we frequently see happen in severe injuries of the scalp, or in cases where the bone is extensively denuded of periosteum.

Necrosis, however, very frequently arises idiopathically, as a result of inflammation of bone, and generally in patients of the strumous diathesis, more especially when there is also a rheumatic complication.

Necrosis, as a result of inflammation of bone or periosteum, is seen in its most marked form when the dense texture of the shaft of a long bone is affected ; and the progress of the diseased action can perhaps be most readily studied in the acute form in which it occurs in young persons. The symptoms and mode of invasion of that form I have already spoken of in my lecture on acute ostitis and periostitis. In these cases there is diffuse and violent action, not allowing time for the dense texture of the affected bone to open out, so as to accommodate the size of the Haversian canals to the distended blood-vessels, or permit of these readily relieving themselves by effusion. The plastic exudation which occurs fills up the Haversian canals, presses upon and interrupts the capillary circulation, and further extends to

and blocks up the canaliculi and corpuscular portions of the bone. Thus vascular supply is diminished, and nutrition interrupted, in a dense unyielding texture, the vitality of which, owing to its peculiar nutritive apparatus, speedily yields to acute action, and acute or rapid necrosis is the result. A large portion of the surface of the affected bone is felt or seen to be bare, and generally of a white appearance, as in a cleanly-macerated bone, but occasionally of a brown colour, if there has been much disorganisation and decomposition of surrounding textures. In all cases of necrosis the pus, or discharges, have a peculiar fœtid odour.

In acute necrosis the actual extent of death of bone is less than it appears to be. Very often a mere thin layer dies and separates, and that not from all the exposed surface. The surrounding soft parts are thickened and vascular; and more especially we notice changes in the periosteum, which has separated from the affected surface. It has a thick, fleshy, and extremely vascular appearance, and in its substance there are felt small nodules of osseous matter (see Fig. 1, Plate xi.) At one time these were considered as being formed in the periosteum; but if we carefully examine a recent preparation of a bone so affected, we find that, corresponding to each of these osseous masses in the periosteum, there is a depression in the dead surface of the bone from loss of substance. In fact, these osseous points are portions of living bone which have separated with the periosteum; a layer of granulations having separated them from the dead texture, gives them the appearance of being imbedded in the periosteum. In some cases, where the diseased action has affected the medullary Haversian structure, a portion of the shaft may die throughout nearly its whole thickness, but rarely, or rather I would say never (Fig. 2, Plate xii.); for even in very extreme specimens a longitudinal line of irregular rough surface marks where a portion of living bone has separated from some part of the circumference.

In the more chronic forms of necrosis, or, to speak more properly, where necrosis results from a more chronic form of

inflammation, the symptoms, though often severe, are much less painful, and unattended with the peculiar irritative fever which accompanies the acute form. The pain is more of a rheumatic character; and it is only when some exacerbation leads to subacute inflammation and suppuration near the diseased bone that sympathetic febrile symptoms arise. In these chronic cases, the slower action permits of gradual changes taking place. The Haversian openings and canals gradually enlarge from the pressure of the distended vessels, and the whole aspect of the shaft of the bone at the affected part is altered. New bone is deposited in irregular masses near the diseased part, owing to the excited action determining more blood to that part, and so increasing the nutrition of the bone around the dying portion. Wherever we find a completely smooth portion of dead bone, there the new or substitute bone is at first wanting; but the space may be gradually bridged over from the side of the neighbouring shell. This deficiency of substitute bone seems to arise partly from the want of any nuclear portion of bone, and on account of the diseased action having destroyed the germinal lining structure of the periosteum at the parts corresponding to the completely smooth dead surface. At these open spaces the purulent matter formed around the dead or dying bone escapes; and as the substitute shell closes in around, the pus keeps some points open, and thus the cloacæ in the substitute bone are formed, and these again are continuous with the sinuses or cloacæ in the soft parts.

After a lapse of several weeks the dead portion becomes separated from the living bone, and is ready to be thrown off naturally or removed by the surgeon. The complete separation of the dead bone from the living is always a slow process, even in acute necrosis, seldom occurring until six or seven weeks from the commencement of the disease, often very much longer, and in some cases only gradually accomplished, one small portion separating after another. This is especially the case when the medullary Haversian structure is affected. The

portion separated is termed either exfoliation or sequestrum, according to its form. Thus the superficial thin laminæ of dead bone separated from the cranial bones, from the popliteal space of the femur, or from the surface of the tibia, in acute necrosis, are termed exfoliations; whilst the larger cylindrical portions, comprising a considerable thickness of the bone, or portions of dead Haversian structure from the medullary canal, are termed sequestra.

Necrosis may either be superficial or internal. In the latter case, or in cases where a considerable cylindrical portion of the shaft of a bone dies, as the process of separation is slow, new bone, as I have said, forms around or bridges over it, and so forms a barrier to its extrusion. Hence, in the two last-mentioned forms of necrosis, the substitute bone must be destroyed by the ulcerative proccss to make way for the exit of the sequestrum ere nature can extrude and so get rid of it; and I need hardly say that this is necessarily a very tedious process. The sketch I show you (Plate xi. Fig. 2) is from the case of a woman aged 30 years, in whom the disease began when she was about 13 years of age. I had seen her from time to time during fifteen years on account of exacerbations caused by the presence of the sequestrum, but she refused to submit to any operation. At last the sequestrum was extruded by the natural proccss, so that I merely required to draw it out with my fingers, but this only after great suffering and risk. The sequestrum was composed of about three-fourths of the thickness, and nearly the whole length, of the tibia of a girl of 13 years, and maintained its original shape, marking the period at which its death had occurred.

The presence of a sequestrum in the vicinity of the articular end of a bone is always attended with risk of exciting unhealthy inflammation in the cancellated texture of the epiphysis, and so involving the joint; and this complication forms an important element in our prognosis as to the probable termination of the case, or in regard to surgical interference.

Death of a long bone throughout the whole length and

Plate XII

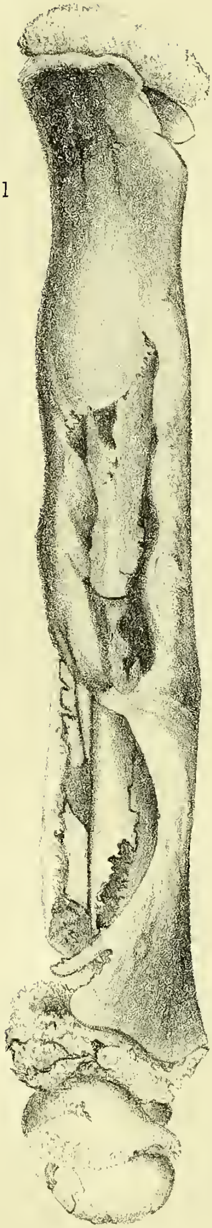


Fig. 1

Fig. 3

Fig. 2

Fig. 4

Waterston & Son Edin. Lith

thickness of the shaft is occasionally spoken of by surgical authors, and formerly the long sequestra resulting from acute necrosis used to be appealed to as evidence of this—the rough irregular patches on their surface, or the deficiency in their circumference, being attributed to the action of the absorbents on the dead bone !* No one now believes in this action of absorbents, and I have already explained that such deficiencies are due to the separation of portions of living bone during the progress of the disease. If death of the entire shaft did occur, we would expect to find the bone lying loose from the periosteum, unaltered in form, and presenting a uniform smooth surface like a macerated bone, and separated at either extremity from the epiphyses. But though my own museum presents a very large collection of specimens of necrosis and some very large sequestra, and though I have examined carefully many public collections at home and on the Continent, I have never yet met with such a specimen as death of the shaft of a long bone in its entirety. Even in the most rapid cases, portions of living bone separate from the shaft along with the periosteum, or in connection with the epiphyses.

In some cases, after sequestra have been removed or thrown off by the efforts of nature, the discharge does not cease, but continues thin and gleety, and the constitution begins to suffer. In some cases the discharge is so copious as to be exhausting and demand very decided measures. In others, an unhealthy fungoid growth springs from the cavity, bleeding occasionally, and so exhausting the patient. This last condition occurred in the case of the woman already referred to, and was accompanied by all the symptoms of malignant action. She was yellow from anæmia caused by loss of blood, worn to a shadow, and there were enlarged glands in the groin. These symptoms supervened about eighteen months after the sequestrum had been extruded, and I amputated her thigh some three or four months later, and she made an excellent recovery. All the symptoms were due to exhaustion from pain and loss of blood, not to malignant action, and I have seen several cases of somewhat similar kind.

* See Plate xii, Fig. 2.

In some instances where necrosis occurs near or at the junction of the shaft with the epiphysis, deformity occurs in consequence of the epiphysis getting loosened and altered in its relation to the shaft, as we often see in necrosis in the lower part of femur in children.

X The appearances of a limb affected by necrosis will vary under different circumstances. In a thickly covered bone, such as the femur, the inflammatory swelling and pain which precede necrosis give rise at first to tension, acute œdema, and deep-seated suppuration; so that all the soft parts of the limb become altered, thickened by infiltration of plastic exudation and solid œdema, so as to become firm and unyielding, and present openings of sinuses leading, more or less directly, to the diseased bone. In necrosis of a superficial bone like the tibia, in acute cases we have the swelling and erysipelatous redness of the skin, effusion of lymph into the subcutaneous areolar tissue, and when abscesses burst or are opened, and when incisions are made, we see the dead bone bare and white. In chronic necrosis of the tibia, the deposit of new substitute bone altering its form, and the thickening of the whole limb caused by solid œdema, give the leg an unshapely appearance; whilst the skin is usually congested and discoloured, and, as in all cases of necrosis, we have the cloacæ or sinuses leading to the sequestrum, or cavity where a sequestrum has been.

The constitutional symptoms will vary as the necrosis is acute or chronic. In the former we have all the intense symptoms I described when speaking of acute ostitis and periostitis, the worst form of irritative fever and exhaustion. After this stage has passed, and when death of the bone has taken place and suppuration begun, the irritative fever is relieved; but hectic, more or less marked, sets in. In chronic cases there may be severe exacerbations depending on formation of abscesses, but the irritative fever is never so intense as in the acute form. When suppuration occurs and is kept up by the presence of the dead or dying bone, hectic symptoms occur as after the acute, being caused in both cases by the continued irritation and discharge.

There is a form of necrosis which is occasionally met with in

extremely strumous patients, or in persons of strumous constitution, with a syphilitic taint either hereditary or acquired. The symptoms are generally of a low type. There is but little preceding inflammation or swelling of the limb or bone. An abscess may form, enabling us, after opening it, to touch bare bone at some one point only; whilst, in fact, the whole, or a large part of the shaft, is affected by little patches of necrosis, the dense structure of the shaft is opened out and carious-looking, and there is little or rather no attempt at repair—no new bone thrown out around the dead portion. In this form the bone is very friable, and fracture is apt to occur. In the case of the lad from whom I obtained the specimen I show you, an abscess formed in the popliteal space, and the surface of the femur there was felt bare and rough. As it did not exfoliate, he got tired and left the hospital. I was sent for to him in a great hurry shortly afterwards, and found the femur broken a short distance below the lesser trochanter. I had him carried to hospital, and there amputated the thigh just below the trochanter. There had been no swelling, pain, or deformity, nor any symptom of disease, except at the popliteal region, and yet you see the state of the bone at the broken part, and for some extent upwards and downwards from that point. The lad made a good recovery from the amputation, but when about to leave the hospital, general dropsy suddenly supervened, with albuminuria; this yielded readily to treatment, and after being in the country for some months, he returned quite ruddy and feeling strong, but his urine was as albuminous as when he left. I saw him from time to time for seven years, always seemingly in good health, no œdema or other bad symptom, but the urine always so coagulable by heat as to be nearly solid. He was suddenly seized with lumbar pains; suppression of urine took place; and when I saw him, twenty-four hours after his seizure, he was comatose and moribund, and died two hours later. I mention this case and show you the specimen as typical of this form of patchy necrosis.

Before proceeding to speak of the treatment, I desire to draw your attention to the necrosis of scrofulous patients and its relations to caries.

Most of our surgical works would lead us, by their language, to suppose that, in constitutional forms of necrosis, if we once but remove the "sequestrum," all will go on satisfactorily. Such, however, is very far from being the case in many instances, and for this simple reason, that the originating or predisposing cause, the constitutional diathesis, still continues after the local irritation has been removed; and hence, in many cases, after removing a "sequestrum," we find the exposed surface still continues to discharge, and fresh portions become necrosed—nay, in many cases the cavity left after removal of the necrosed portion continues to furnish discharge so persistently as to exhaust the general health and necessitate amputation to save life. Again, we meet with various forms or modifications of the disease. In some the death of a portion of the affected bone is rapid and complete, and a comparatively healthy surface is left; or the reparative efforts of nature may have furnished a case of substitute bone ere the sequestrum is thrown off. In others, the progress is slow, the affected bone retaining slight vitality, and not becoming completely separated for a lengthened period—the texture of the bone from which it separates is seen to be discoloured, friable, and of low vitality; and in other cases we find the shaft of a bone affected at different points, with independent patches of necrosis, without the slightest effort at repair.

We have already examined the condition termed caries. Let us now compare it with necrosis, and ascertain in how far these conditions differ from or resemble each other in their essential nature, whether they be absolutely different diseases, or merely the same diseased action differing in degree, or modified by the texture of the bone in which it occurs.

When we view two specimens, such as caries of the articular surface of the tibia and necrosis of the shaft of a long bone, there seems at first sight but little in common; but it is not by extreme forms that we must judge of the essential character of disease, but by tracing it through intermediate links, and having done this, we will often find, even in the extremes, more points of resemblance than at first appeared. Thus, if we take a

specimen of incipient necrosis of the popliteal surface of the femur, we find the affected part of a brownish colour, of more granular appearance, and more friable than natural, but still possessing some vitality; and making allowance for the naturally denser texture, not much unlike the surface of bone exposed in articular caries. Again, in advanced stages of articular caries itself, we often find large exfoliations or sequestra of the cancellated structure separating, constituting necrosis. In certain bones, especially the lower jaw and tibia, we meet with what has long been termed molecular necrosis: that is, the dead surface gradually becoming disintegrated, and being thrown off in particles so minute, as to be almost imperceptible, until the whole diseased portion is eliminated and a healthy surface left. In cario-necrosis, as it is termed, we have a combination of the two conditions in the different textures of the same bone, showing that it is the texture which modifies the diseased action. Thus, in the bones of the tarsus and carpus, the cancellated portion presents the appearance described as caries, whilst the denser fibrous lamella is completely dead and exfoliating. We meet with this condition also in some rare cases in the shaft of long bones, where the bone has undergone chronic alteration of structure, and has become opened out in texture, so as somewhat to resemble cancellated bone, and presents an unhealthy friable appearance with small patches of exfoliation at different points, and scarcely any attempts at repair or deposition of new bone. I have a very perfect specimen of this rare form, which occurred in a lad whose case I have already adverted to. Another very rare specimen in my possession shows the effect of diseased action simultaneously affecting the whole extent of the femur, from the hip to the knee-joint, in a young girl; here the form of disease, as depending on structure, is beautifully seen, the dense shaft has been rapidly deprived of vitality, whilst the head and condyles are in a state of cario-necrosis. Lastly, let us return to the ordinary carious articular surface, and examine it more closely with a low magnifying

power, and we will find that a large proportion of it is composed of fine white spiculæ, evidently deprived of vitality, and about to be separated from the living bone.

But it is said that the progress of the two diseases is different; that necrosis is amenable to treatment, whilst caries is incurable. Let us examine, for a moment, into this opinion, as to the peculiarly incurable nature of "caries" in comparison with necrosis.

I apprehend that all that is meant is just this, that the actually carious portion is incurable, and of this there can be little question; the part so diseased must either be thrown off by nature, or artificially removed; but wherein lies the difference between it and necrosis in this respect? The part actually necrosed is also incurable, and it, too, must either be thrown off or removed before a healing process begins; at the very most, the difference is, that the carious surface possesses some slight degree of vitality, which renders the process of exfoliation or disintegration by molecular necrosis slower, and is rather a modification of diseased action from the structure of the cancellated bone in which it occurs, than a different disease. But then it may be said that there is more meant by the incurability than this, for we see that "caries" in the articular extremities of bones leads to such exhausting disease as to destroy the patient, or necessitate amputation or resection, much more frequently than "necrosis." This is simply to say, that from the *relative* position of the diseased portion of bone, general disease of the articular structures is induced, and so the patient's life endangered and severe operations necessitated.

As regards the distinctive definitions, that caries implies an ulcerated surface of bone, possessing a low degree of vitality, sufficient to prevent its being thrown off, but insufficient for undergoing any healthy action, whilst necrosis indicates complete death of the affected portion,—these may be correct etymologically, as indicating different stages or degrees of diseased action, or rather the action and its result, and I have no objection to the terms, as used for that purpose; what I wish is, to ascertain whether

the original essential nature of the disease, however modified, be the same in both cases. But even the slight vitality of the carious surface may be doubted; for when we look at the white, spicular, and altered structure, we see but little to indicate vitality; it is, in fact, molecular death; whilst here, as in ordinary necrosis, we have active reparative efforts at deposition of new bone. In fine, we see, in many cases of necrosis of the shafts of bones, carious-looking bone, beyond the exfoliation, and in many cases of "caries," distinct exfoliation going on.

What, then, is the essential nature of these conditions? I hold, that they are both manifestations of scrofula, affecting the osseous texture, leading to altered and impaired nutrition, predisposing to and often exciting an unhealthy form of inflammation. In other words, the unhealthy and impoverished condition of the blood, characteristic of scrofula, furnishes an exudation of plasma less fitted for proper nutrition, under ordinary circumstances, or to resist disease when excited, and under certain conditions undergoes peculiar and abnormal transformation. Thus, as we see, the deposition of tubercle in some textures, or the gelatinous degeneration in synovial membranes, so in bone, the unhealthy blood-plasma exuded from the capillaries ramifying in the Haversian structure leads to the diseased states I have been considering. We observe this most evidently in the altered condition of the cancellated texture of bones in strumous patients, where the altered medulla or lardaceous deposit is so marked, that we frequently see, under some increased irritation, tubercular alteration and ulceration occur. Here it is easily recognised, because the looser texture and greater vascularity of the cancellated bone favour its occurring more readily and in a larger quantity, whilst the same conditions of the bone prevent the diseased action leading to rapid or complete death.

In the shaft of a long bone, or in the fibrous shell of the short and flat bones, a much less amount of such exudation, slightly if at all capable of healthy transformation, blocking up the Haversian structure, speedily leads to complete death of a portion of such bone, when affected by any increased irritation

from disease or injury. We see this well exemplified in the cases termed "cario-necrosis" of the tarsal bones, where, under excited action increasing the imperfect plastic exudation, the denser shell dies rapidly, and exfoliates, whilst the looser cancellated part loses its vitality more slowly, presenting at some points the molecular disintegration or ulceration, at others deposition of new material, leading to the condensation of the texture, as described by Professor Goodsir. In some cases we have this also exemplified in a general disease of the shaft and epiphyses simultaneously, as in the specimen of the femur already alluded to.

As to practice, these views will modify our prognosis. Thus, whilst they show why the diseased condition is generally more persistent and intractable when it occurs in the cancellated texture, they also point out how, in some cases of caries, by a process of molecular death, the unhealthy surface of bone may occasionally be disintegrated, thrown off, and so a cure be obtained. They explain the reasons why the cure in strumous necrosis of the shaft is generally so tedious, and often imperfect, even after the removal of all sequestra, and also the tendency to affections of the articulations supervening both from direct extension of disease and from constitutional diathesis. Lastly, they show us the necessity for patience in the treatment after the removal of large sequestra, and for the careful and persistent use of constitutional remedies.

LECTURE XXXIX.

Treatment of Necrosis, before, during, and after the separation of sequestra—Mode of conducting operations for Necrosis—After treatment—Question of amputation—Rachitis or Rickets—Mollities ossium.

WHILST lecturing on acute and chronic ostitis and periostitis, I described fully the remedial measures necessary to fulfil the indications of treatment of the conditions which terminate in death of the bone. When the more acute action has been subdued, and when the irritative fever which accompanies it has somewhat subsided, and hectic has supervened, the treatment is at first limited to securing absolute rest of the limb, by laying it on a wire splint suspended from a cradle, and to careful watching so as to notice and evacuate early any abscesses which may form. We apply charcoal poultices or warm-water dressing sprinkled with carbolic acid solution or chlorinated soda lotion to the surface, to correct fœtor. The patient's strength should be supported by means of nutrient diet and wine or other stimulants, according to circumstances, and the use of muriated tincture of iron in small doses. We must wait patiently until the sequestrum or exfoliation becomes loose and separated by nature, to effect which, as I have already said, several weeks at least are required. After the lapse of five to six weeks, we may examine with the probe, to ascertain if the dead portion be loose or loosening; but this should be done as seldom as possible, and no force used. It is sometimes difficult to be sure whether a sequestrum is still attached to the living bone—not fairly thrown off; or whether it is merely fixed by some process of substitute bone, or by irregularities of its deep surface caught by corresponding irregularities of the living bone. This difficulty in diagnosis is most likely to occur in internal necrosis, and if the sequestrum be flat. Where there are two or

more cloacæ leading to the sequestrum from different aspects of the limb, we will often find that whilst the probe cannot move the sequestrum when introduced by one opening, if we introduce it by the opening on the opposite side of the limb we at once displace and move it readily. I have also found it useful to examine with a steel probe terminating in three short thick points, which catch the smooth surface of the sequestrum and move it if it be loose, instead of moving on its surface. In superficial necrosis, as that of the. cranial bones or tibia, the exfoliation is frequently detached vitally, but remains attached by mechanical cohesion of the opposed surfaces and atmospheric pressure; and whenever we raise the edge of the exfoliation and tilt it a little over, the whole comes away readily.

In deep-seated necrosis, where the sequestrum is imprisoned in the medullary cavity of the bone, or in a case of new substitute bone, and where we feel it loose, or where we know that due time has elapsed to insure its having separated vitally, we must have recourse to operative interference for its removal, so as to prevent it from exciting mischief in neighbouring joints or other parts.

Operations for necrosis are often tedious and laborious, especially in chronic cases, where the substitute bone is thick and almost of the density of ivory. There is no possibility of laying down positive rules for such irregular operations; but there are certain points which should be specially attended to.

First, as regards hemorrhage. Means must be taken to arrest bleeding during the operation, as the vascularity of the textures, and their almost cartilaginous thickness by preventing the retraction of divided vessels, cause the hemorrhage to be always very smart and often profuse; and as such operations are frequently protracted, the loss of blood might be serious unless the precaution of using a tourniquet were adopted. Secondly, we must not only make our incisions in the soft parts free, but in order to reach the diseased bone, we must dissect them back on either side; as they are altered and thickened, and do not retract as they would in the natural state of parts, we can gain no room but by dissecting.

This dissection, of course, is limited to laying bare the substitute bone to a sufficient extent to enable us to deal with it according to circumstances. Before proceeding to operate, we if possible ascertain the length and thickness of the sequestrum, its proportion to the cloaca or opening in the substitute bone, and the probable thickness of the substitute bone, and are so far prepared to act on some plan. It will, however, often happen that on laying bare the bone, we find it necessary to alter our proposed plan, and hence our apparatus should in this operation be ample. The instruments usually required in dealing with the bone are, the trepan, straight and curved bone-pliers, a fine narrow saw, gouges of different sizes, necrosis forceps straight and bent, probe, elevators and ordinary dressing or polypus forceps, for small sequestra or narrow openings. When the sequestrum is large and long, and the substitute bone not very thick on one side, as little of the latter as possible should be removed. In such cases we try to catch and divide the long sequestrum across by means of bone-pliers, then push the fragments up or down, and extract first the one and then the other through the opening in the substitute bone.* In other instances, where the case of new bone is very dense, we apply the trepan to make an opening in it, and enlarge that further with a fine saw or bone-pliers, till we can insert and use our extracting forceps. In such operations the trepan is always preferable to the trephine, as it renders the operation less fatiguing to the surgeon, and works more rapidly, and there is of course no risk in using it here. In some cases we split up a large sequestrum, both longitudinally and transversely, and extract it in small portions, so as to save the substitute bone. In dealing with superficial necrosis, or with sequestra, where little new bone has been thrown out, there is not much difficulty experienced in detaching and removing them.

After operating on cases of necrosis, the bleeding is to be arrested, large vessels must be tied; but as the profuse bleeding alluded to formerly arises from the general vascular surface, we usually command it by stuffing the cavity with lint. The density

* Plate xii. Fig. 1.

of the textures favours compression, so that bleeding is in general very easily arrested. After the operation is completed, we place the limb in a splint and swing it, to insure rest and prevent fracture of the substitute bone at any weak point. The after-treatment is simply that of a granulating wound.

In cases in which sequestra have been removed, and where discharge continues, exhausting the patient, whilst no dead bone can be felt, we must lay open the cavity in which the sequestrum had been situated, and insert a slip of lint soaked in tincture of iodine or other stimulant, to excite healthy action and destroy the pyogenic membrane. Stimulating lotions should then be injected from time to time, until the soft parts contract and close in upon the cavity. In cases where large sequestra have been removed, or where the substitute bone is not much developed, or in which we require to remove a large portion of it to reach and remove a deep-seated sequestrum, it is advisable to place the limb on a wire or light wooden splint, and sling it so as to give support to the remaining substitute bone, and prevent fracture, either from the patient turning in bed or from the action of the muscles. And this is absolutely essential when there is only a single bone, as the femur or humerus.

The constitutional treatment in cases of necrosis must be carefully attended to. Nourishing diet, cod-liver oil, preparations of iron—especially the phosphates—and iodide of potassium, are indicated to support the patient's health, and act as alteratives on the strumous diathesis.

The question of amputation frequently arises in the treatment of necrosis under different circumstances. I would therefore now conclude this subject by directing your attention to the conditions under which this question may arise.

In cases of acute necrosis of great extent, when the patient is suffering from irritative fever, with symptoms almost of blood-poisoning, and when the intense suffering, gastric irritation, and debility, leave us little hope of his being able to pass through the long process required for throwing off the dying bone, amputation presents itself as a chance of relief, but I

would strongly guard you against giving way to the temptation. These conditions which tempt you are no doubt most dangerous, and it is quite possible that your patient may sink under them; but they are conditions most unfavourable for amputation, and after much experience in the treatment of such cases, I tell you that the patient has a much better chance without the operation. When the irritative fever ceases, and hectic fever with profuse discharge takes its place, when the tongue cleans, and the perspirations are profuse, if your patient's health is sinking, or if neighbouring joints become affected, then amputate. But even in hectic cases, where there is no joint implicated, it is wonderful what a youthful patient will get through. Therefore exercise patience, and don't be too ready with the knife. Perhaps one of the most difficult lessons we have to learn by experience is when to watch disease and do nothing.

In cases either of acute or chronic necrosis, when neighbouring joints become diseased, and discharge and pain give rise to hectic wasting; or when, as often happens, the necrosis is attended with altered position of the epiphyses rendering the limb irremediably deformed and useless, then amputation is evidently indicated as the best means of removing at once the cause of irritation which is exhausting the patient and a useless and deformed limb.

Another condition generally requiring amputation is fracture of necrosed bone, as in patchy necrosis, where there is little or no tendency to substitute bone being formed; or in cases where the substitute bone breaks after a sequestrum has been removed or thrown off. In the former of these cases, the peculiarly unhealthy state of the bone, and the absence of reparative action, leave little or no choice but to amputate. In the latter our decision will depend on circumstances. When such an accident occurs in the humerus or femur, where there is only a single bone, the chances of solid union are very small, especially if the patient be debilitated by previous suffering. In the femur, under these circumstances, besides the risk to life from increased irritation and discharge, the limb saved would be very useless,

or perhaps worse than useless ; and hence amputation would be the proper practice. In the case of the humerus, however, the chances of repair are greater, the treatment is attended with less risk to the patient, and does not necessarily imply confinement to bed or in the house. The arm can be placed in appropriate splints and slung. And supposing—as may often happen,—thorough union of the humerus should not take place, the upper arm can be fixed by apparatus, and the use of the hand and forearm retained. Here, as in cases of injury, we should never resort to amputation whilst a chance remains ; and, I may add, our efforts are usually successful. I have never amputated the arm, nor can I recollect ever having seen amputation performed, for such a cause.

Where there are two bones, as in the leg and forearm, amputation for fracture of substitute bone can rarely be requisite. In the forearm it would seem to me to be quite unwarrantable. Even in the leg, though the fibula is of itself a very slight support, yet it suffices to maintain the position of the limb at first, and the ends of the broken substitute bone of the tibia, if they do not unite with each other, become connected with and strengthen the fibula. Lastly, in cases where, long after sequestra have been removed, the cavity continues to discharge unhealthy pus, notwithstanding that it has been laid open and treated with iodine or other stimulant applications, or in cases were fungoid growths spring from such cavities, and are exhausting the patient by discharge and loss of blood, amputation becomes absolutely necessary to save life.

One of the many forms in which the scrofulous *diathesis* seems to manifest itself, is the disorder which is known by the name of RACHITIS or RICKETS. This, together with the apparently allied diseases mollities ossium and fragilitas ossium, will form the conclusion of the present lecture.

Rachitis and mollities ossium have one common feature, inasmuch as they are both diseases characterised by a preternatural softness of the osseous textures, due to a deficiency of

their earthy constituents. In rickets this deficiency is due to non-development and mal-assimilation of the materials necessary to the formation of bone, while in mollities ossium it arises from absorption and degeneration of already existing bone. The one is therefore a disease of childhood, the other of advanced life.

Rickets occurs in children either as a primary disease or as a consequence of the debility induced by infantile complaints, such as measles, scarlatina, hooping-cough, and the irregularities attendant on dentition. Most usually the subjects of it are originally of weak constitution, and, as I have already indicated, it has always been regarded as one of the many manifestations of scrofula. Still, we must bear in mind, that although often very closely associated with scrofula, it does not seem to possess a well-established claim to the hereditary character of that disease. The children of very young parents are peculiarly liable to it, and that independently of any already existing disease.

Although softening of the bones, and the resulting deformities, are the most prominent effects of rickets, yet the disease presents many other symptoms. The patients are of a pale sallow complexion, dull-looking, fretful, and peevish. The body is generally attenuated, or if not, the flesh is soft and flabby, not firm and bright as in health. The chest is contracted and deformed, the belly prominent and tumid. The lower limbs, being unable to support the body, become bent and twisted under the conjoined forces of gravity and muscular contraction. Bending of the limbs, however, does not necessarily imply the presence of rickets, for the limbs of any child, however healthy, will become distorted if it be allowed to rest its weight upon them too early, and before the shafts of the bones have become sufficiently ossified to sustain it.

In rickets, not only is there a deficiency of earthy matter originally, but there would almost seem to be a want of power in the system to assimilate the earthy salts, for during the progress of the disease there is often a great elimination of phosphate of lime from the system, as shown by deposits in the urine. In

rickets, however, the soft, cartilaginous, or opened-out structure of the bones is only temporary, it being, as I have said, a disease of childhood and youth. After a time earthy matter is deposited in the bone, which then becomes firm, but porous and generally light in texture, often much bulkier than natural. In the shafts of the long bones the curvatures which had taken place during the soft stage remain, and so the bone becomes permanently deformed, unless means are used to obviate this. Every museum possesses numerous illustrative specimens, and in examining these you will observe that there is always a large deposit of ossified matter in the concavity of the curve, similar to what occurs in badly-set fractures; thus the maximum of strength is obtained by the minimum of expenditure of material.

All the other bones may be similarly affected, but more especially those of the cranium, which become greatly enlarged, as they do in chronic hydrocephalus, and indeed these two diseases are not unfrequently associated with each other.

In females, it would seem as if rickets sometimes occurred at a later period of life in consequence of debility induced by leucorrhœa, menorrhagia, miscarriages, and floodings. When the bones of the female pelvis are so affected and distorted, and again become firm from earthy deposit, the deformity is rendered permanent, and constitutes an obstacle to delivery during subsequent labour.

The *Treatment* must be chiefly directed to the constitution. Fresh air is of the greatest consequence. Passive exercise should be recommended, but only of a very gentle kind, and not carried so far as to produce fatigue. Tepid water, and even sea-bathing, is very beneficial where judiciously conducted, and accompanied or followed by gentle and somewhat prolonged use of the flesh-brush.

The diet should be nutritious, and carefully regulated in accordance with the digestive powers of the patient, and wine or other stimuli may be given if necessary. Formerly preparations of lime were freely administered, but that practice arose from misapprehension regarding the nature of the disease, and was

therefore useless, or worse. The diseased state consists, not in any deficiency of earthy matter, but in the want of power to assimilate it. For this reason the medical treatment ought to be directed towards the restoration of that power, and for this purpose preparations of iron, cod-liver oil, and especially pepsine wine, seem to be the most suitable remedies, together with such gentle laxatives as may be required for the proper regulation of the bowels. The use of pepsine wine seems to be specially beneficial, as it improves the digestive powers and so assists nutrition.

In the local treatment of this disease, mechanical appliances may be necessary. These are designed with a view to assist the lower extremities in sustaining the weight of the body, and prevent them from being injured by the superincumbent weight. They should not be had recourse to without great caution, and, if used, should be constructed with nicest care, and of very light materials ; otherwise they will tend rather to aggravate than remedy deformity.

I have mentioned gentle exercise, but this must, of course, be regulated by the stage and extent of the disease. Thus, when the bones of the lower extremity are soft and pliable, walking or standing is obviously contraindicated ; and the patient requires often to be kept in the recumbent position. In slighter cases, care must be taken to prevent the patient from remaining long in one posture, either in standing or sitting, or whilst engaged in writing or drawing, as the position so assumed very frequently becomes permanent. Gymnastics, therefore, ought to be so regulated as to meet the morbid tendency.

Mollities Ossium is the term which is generally applied to that condition in the adult or aged which resembles rachitis in the child. This resemblance, however, only holds good as regards the softening of the bone which is found to exist in connection with each, for pathologically there is no similarity whatever between the two diseases. The one is a suspension of the functions of assimilation in regard to the formation of bone, and is only of temporary duration. The other is an atrophy or

degeneration of bone already existing, which is not temporary but progressive, and continues to extend from bone to bone without any interruption or attempt at reparation, until at length the general health becomes involved, and the patient dies from exhaustion.

Various opinions are held as to the true nature of the changes which take place in the bones during the progress of this disorder, and indeed there is reason to believe that these are not the same in every case. Sometimes the earthy matter of the osseous texture seems to be absorbed, and its place filled by a brown lardaceous soft substance; whilst in other cases the change seems to partake more of the character of a simple softening. Mr. Paget seems to view the disease as a fatty degeneration of bone, similar to that which occurs in other textures late in life, and the correctness of this opinion receives strong confirmation from the results of the analysis of such bones, for they are found to contain free fat in very large proportions. Rokitansky, on the other hand, seems to hold that the changes consist in simple softening of the bone, from abstraction of its earthy matter, and persistence of its cartilaginous base, constituting rickets of the adult. This latter class of cases is that already alluded to as occurring in adult females, and is a distinct disease from true mollities, which is continuously progressive.

Mollities ossium is always attended with intense and incessant pain, which increases with the progress of the disease. The patients become enfeebled and emaciated, their appetite fails, they are sleepless, irritable, and subject to profuse perspirations. So that, in addition to the local discomfort, there are very marked evidences of a constitutional cachexia; in fact, the symptoms present all the characters of malignancy.

From what I have stated regarding the *progress* of the disease, you will, no doubt, gather that the *Treatment* can only be of a palliative kind. The indications are to regulate the digestive organs, preventing torpor of the bowels, and to exhibit anodynes from time to time, for the relief of pain.

Fragilitas Ossium denotes a condition of the osseous textures

characterised by great brittleness. A certain degree of fragility occurs naturally in old age. This is due to the altered relative proportions of animal and earthy constituents of which bone is composed at that period of life. That condition is much aggravated by the co-existence of certain forms of disease—such as rheumatism. It may also occur purely as a consequence of disease, and that at any period of life. In these cases the bone assumes a friable condition, and may snap across from the slightest cause, even from the simple action of the muscles, constituting in that case what is sometimes termed spontaneous fracture. In cancerous affections this fragility is often present, consequent upon the deposit of cancerous matter in the structure of the bone.

When fracture does occur under these circumstances, union is always slow and imperfect, if indeed it take place at all.

The *Treatment* must be preventive and palliative, for we cannot avert or arrest the alterations in the osseous tissue. The diet must be nutritious, and the patient cautioned against making any exertion lest fracture should occur. The fractured parts must be kept at perfect rest.

LECTURE XL.

Diseases of Joints: how modified, according to the structure affected; whether Osseous, Cartilaginous, Fibrous, or Synovial, etc.—Acute Idiopathic Inflammation of Joints: Causes; Symptoms; Pathology and Treatment.

Owing to the variety of textures which enter into, or are connected with, the structure of articulations, you will easily understand that their diseases are both numerous and complicated; and whether they be regarded as to their effects on the usefulness of the limb or the state of the general health, or both, they demand great attention from the surgeon, in reference to their diagnostic symptoms, pathology, and treatment.

In investigating the symptoms and pathology of diseases of joints, as bearing on diagnosis and treatment, we must carefully bear in mind the peculiarities of the anatomy, and the greater or less degree of vitality of the different structures entering into the formation of the joint. The anatomical peculiarities of the articular extremities of bones have been already noticed; but besides these peculiarities, as compared with those of the shafts of bones, we must here bear in mind their relation to the articular cartilage which encrusts them. This structure, finely organised, in one sense—for the purpose of protecting the osseous texture and admitting of free smooth motion—is of very low organisation as regards vitality. So far as the most careful modern investigations go, it presents neither vessels nor nerves in its intimate structure. Its nutrition seems to be entirely derived from the plasma attracted by its cells from the loops of capillaries which ramify on the surface of the articular ends of bones in connection with it. In such non-vascular structures the vitality is not only low, but also closely bound up with the condition of the neighbouring textures on which they depend for

their supply. On the other hand, the protection which the cartilage of incrustation affords to the articular ends of bones during motion or contact, explains how certain symptoms arise, when, either by acute or chronic action, the cartilage has been removed, and this protection more or less lost.

In some articulations we meet with what are termed inter-articular fibro-cartilages. These, owing to their fibrous connections becoming relaxed or destroyed, may become sources of mechanical obstruction to movement, and lead to or keep up irritation in the joints. The true fibrous ligamentous texture of joints, whether in the form of capsular, flat, or cord-like ligaments, possesses the usual characters of fibrous tissue; a dense resisting structure with a moderate vascular supply and innervation. This texture is capable of undergoing rapid alteration of structure from acute inflammation, or gradual change and thickening from chronic inflammation, also calcareous alteration, or ossification as it is sometimes termed.

The most peculiar anatomical structure in joints, perhaps, and that which is most frequently affected either primarily or secondarily, is the synovial membrane. This invests the articular ends of bones, the cartilage of incrustation and the internal surfaces of the fibrous structures of joints being reflected from off one surface to another. The synovial closely resemble the serous membranes in their anatomical arrangement and functions. Like them they are shut sacs, possessing a smooth serous-looking surface, and their function is to secrete a lubricating fluid, the synovia, which, though more viscid than serum, serves similar purposes. Although the membrane is apparently possessed of little vascularity in its ordinary state, yet under any irritation its vessels readily enlarge, the membrane becomes injected, and its secretion increased and altered. This vascularity spreads rapidly and diffusely over its free surface, inducing changes in action and affecting indirectly other textures.

Besides the articular structures proper, there exists, near most articulations and around tendons, another apparatus very analogous in its structure and uses to the synovial,—I mean the bursal

texture. Bursæ mucosæ, as they are named, are just sacs of synovial character placed over joints or bones, or between tendons and the skin or muscles, to protect them from external pressure, and at the same time permit of easy motion. They are sometimes formed adventitiously when a part is exposed to continued abnormal pressure. Their anatomical character, the nature of their secretion, and functions, differ little if at all from those of the synovial sac, and there is therefore considerable similarity in their pathology.

Requesting you to keep in mind these general views of their structure, I now proceed to speak of the diseases affecting joints.

Inflammation of a joint may arise idiopathically from some constitutional predisposition, such as the rheumatic, strumous, or syphilitic, excited perhaps by exposure to cold or damp, or without any very obvious exciting cause. Or it may arise from injuries, such as sprains, bruises, or penetrating wounds. The invasion and progressive symptoms of the inflammation will be modified by the circumstances giving rise to it, and our prognosis will be much influenced by the constitutional predisposition or diathesis of the patients in whom it occurs.

In cases where the inflammation arises from cold or damp, it generally partakes more or less of the rheumatic character, and the fibrous articular textures are first affected. There is not much swelling at first, but deep-seated pain in the part, aggravated by motion, especially by particular movements in different joints. The pain is most severe at night, and partakes of a peculiar tense aching character. Febrile symptoms supervene. The pulse rises, becomes hard and frequent. A hot dry skin occasionally alternates with profuse perspirations. The tongue is foul and loaded, and the urine scanty and high coloured. Sometimes the fever is, from the first, of the irritative type.

When these symptoms have continued for a short time, swelling begins, at first slight and œdematous, in consequence of the vessels relieving themselves into the areolar texture external

to the fibrous ligaments, and thus filling up the depressions, so that the natural form of the joint is somewhat lost or altered. Shortly, however, the synovial membrane becomes involved. The pain then becomes more diffuse, and of an acute character, and the joint becomes distended with increased and altered secretion, causing either a uniform swelling or bulging at those parts where there is least resistance. Thus, in the knee-joint, if the patient be recumbent, the swelling is at first greatest on either side of the ligamentum patellæ, and over the lower and fore part of the thigh. If the patient be erect, the bulging is over the upper part of the tibia. Laterally and posteriorly the strong fibrous structures resist the distension for a time, though by-and-by they gradually yield before the pressure of the fluid. In cases where the joint is superficial, as the knee, the skin becomes hot and often inflamed, and either tension or acute œdema may arise.

When the synovial membrane is primarily affected by inflammation, the pain is generally of an acute character, and is referred to one particular spot at first. The patient often says that he could cover it with the point of his finger, and this even when from the swelling it is evident that the action must be diffused. The same peculiarity as to the localisation of pain is often observed in cases of pleurisy, and occasionally in peritonitis at the commencement. In synovitis the progress of the swelling is more rapid than when the fibrous textures are originally affected; but in either case, when once the synovial membrane is involved, the after progress of the symptoms, whether local or constitutional, is the same.

As regards the physical signs. Besides the swelling in cases of synovitis, we have in the early stage, before effusion is extensive, a feeling of friction on moving the surfaces gently on each other. Or a friction-sound is heard if we apply the ear over the joint when slight passive movement is made, but we elicit it most readily by manipulation. When the effusion into the joint is considerable the friction is lost, but is felt again as the effusion becomes absorbed.

The pathological changes which arise from simple inflammation of joints are, thickening and altered form, and after a time either softening or chronic consolidation and shortening of the fibrous ligamentous structures, and in some cases fibrous anchylosis and distortion. In synovitis we find at first effusion or exudation of lymph on the free synovial surface, giving it a granular appearance, and leading to the friction of the surfaces already mentioned. Next rapid effusion of thin, almost serous synovial secretion collects within the joint. In some cases plastic lymph is effused between the opposed surfaces of the synovial sac, forming adhesions. These are short and soft when recent, but when old, they gradually elongate to admit of motion, and become thin and membranous, similar to what we see in old adhesions of serous membranes ; this result, however, is comparatively rare in the synovial. In some cases, where the joints have suffered from repeated attacks, we find some slight alteration in colour, opaque patches, or thickening, and nothing more. In others, and especially in rheumatic cases, a very peculiar fimbriated structure is found, and sometimes projections of a kind of fatty alteration in large masses.

Inflammation of a joint may also lead to suppuration. Then the tension increases, the fever becomes intense and of an irritative type, and finally hectic supervenes. When this happens, it is often followed by disorganisation of all the articular structures, but such a result seldom occurs in cases of rheumatic or simple synovitis. Generally it arises in connection with some strumous condition of the constitution, or takes place when the inflammation supervenes in consequence of penetrating wounds.

The *Treatment* of acute idiopathic inflammation of joints requires to be active at first, both in reference to constitutional and local measures, modified of course by considerations of constitutional tendencies and the state of the patient's health.

When acute articular inflammation arises in a robust healthy person, local depletion by cupping or leeches should at once be

had recourse to. After blood has been removed in sufficient quantity to diminish the active congestion, the limb should be placed on a well-padded light wire or wooden splint, and slung so as to ensure absolute rest. Warm anodyne fomentations should then be applied constantly for some time, or if these be intermitted, the part should be covered with sheet wadding to protect it from cold. Some gentle alterative laxative should be given, and this should be assisted by an enema, so as to prevent the patient straining when the bowels act. When the bowels have been well opened we should give an opiate ; either Dover's powder, or a dose of Battley's solution of opium with a few drops of ipecacuan wine, may be given to act both as an opiate and a diaphoretic. In some cases, when the pulse is very hard and quick, minute doses of tartar emetic with opium may be given, but in most cases I prefer the ipecacuanha. In cases where the rheumatic diathesis is very marked, colchicum wine or small doses of aconite are indicated as special remedies. Also the use of aerated potash-water with lemon-juice for a drink when the patient is thirsty and the urine scanty.

In the after stages of the disease, when acute action has somewhat diminished and the fever is passing off, guaiacum, or the tincture of Actea racemosa in from 16 to 20 or 30 minim doses, may often be given with advantage internally. The local application of blisters or other counter-irritants is of great use in helping to get rid of the chronic congestion and effusion. Some precautions are however required in applying blisters in joint-diseases, more particularly when the affected joint is superficial. In all such cases, before using counter-irritation, we should continue the fomentations or anodyne lotions until the temperature of the skin over the affected joint becomes the same as that of the general surface. If this precaution be not attended to, we are apt to re-excite action in the joint and do harm instead of good. In the after-treatment, when uneasiness and stiffness remain, we should use anodyne liniments either simple or combined with iodine, or paint the skin over the joint with iodine, and give support by bandaging, so as to main-

tain rest of the parts and promote absorption. At this stage the use of iodide of potassium internally is of great service in preventing those chronic changes of texture which are apt to arise from exuded lymph. After a time, passive motion at first, and then gradual active motion of the limb, should be encouraged, and the warm douche used to the joint and neighbouring parts, followed by friction with the hand.

In those cases of articular inflammation known as gonorrhœal rheumatism, active depletion is rarely indicated, but in other respects the general indications are similar to those already stated. If the patient has been using balsam of copaiba or cubebs in any form, these remedies must be abandoned and other means used to allay the urethral irritation. In such cases we generally try, by means of warm bathing and other measures, to restore the urethral discharge temporarily.

When acute or subacute inflammation attacks the joint of a strumous person, our prognosis, as I have already indicated, is less favourable, as chronic changes of a scrofulous character are apt to supervene on the irritation so excited. In such cases the use of depletion by cupping or leeching must be very cautiously employed, if employed at all, for we must keep in mind that there is in such constitutions little reparative power, and hence we should avoid the withdrawing of blood from the system. In some few cases, however, where the pain is intense and the inflammatory action violent, the local abstraction of a small quantity of blood may serve to check the disease at less expense of vital power than would be sustained if the symptoms were allowed to progress. As a general rule, however, we restrict our treatment to perfect rest, anodyne applications, and the constitutional remedies already indicated.

LECTURE XLI.

Traumatic Inflammation of Joints: Symptoms; Progress; Methods of Treatment —Dry cold, or Ice Treatment—Anchylosis: Partial or Fibrous, Complete or Osseous—Conditions which render Anchylosis desirable—Modes of effecting it—Operations for separating Anchylosed parts when necessary—Resection—Hydrops articuli—Loose Cartilages in Joints: Symptoms; Treatment, Palliative and Radical.

In traumatic inflammation, arising when a joint is wounded by a puncture or incision, the local symptoms are not severe at first, and there is little or no constitutional disturbance. At the end of thirty-six or forty-eight hours, however, pain comes on and spreads over the joint, which soon presents a considerable amount of swelling and tension. The wound may ulcerate and break open, allowing some synovial fluid to escape, which so far relieves the tension; but the inflammation still proceeds, and general swelling of the limb occurs. This is accompanied or followed by great constitutional disturbance. The pulse rises in frequency, and becomes altered in character. Rigors of greater or less severity come on, and succeed each other rapidly, and the fever presents a truly irritative character. The secretion flowing from the wound becomes unhealthy and purulent, and abscesses begin to form in the cellular tissue around the joint and between the muscles. There is much excited action; but great debility present at the same time. In a great many of these cases the result is fatal; the irritative fever proceeds, and the patient dies with symptoms of acute pyæmia. Occasionally, however, the patient may struggle through and recover.

The old plan of treatment consisted in the application of warm fomentations and active depletion. These means may arrest the more acute symptoms, but they are seldom of much efficacy.

There is a period of debility which must succeed in consequence of the character of the inflammation, and the thought of this deters us from depleting, even though it might soothe the immediate pain. Another mode of treatment consists in trying to alleviate the inflammatory action by such local measures as making incisions to relieve tension and opening abscesses when matter has formed in the joint. These measures, however, are often unsuccessful; and when a cure does result, it is always by anchylosis, and that only after great risk to life.

In treating a wounded joint, two objects are aimed at—To obtain primary union, and to prevent inflammation. With this view, local and general measures have been proposed, the former of which are the more important, and include rest, position, and the application of cold.

The employment of ice as the cooling agent is not a novel practice, but it is not so generally adopted as its merits appear to warrant. It is much to be preferred to irrigation with cold water, both because a *dry* cold is obtained, and a lower temperature produced, and because it can be much more easily and efficiently applied. With irrigation, the wound and surrounding skin are constantly kept in a sodden condition, so that primary union is frequently prevented, and a painful state of the skin often produced. Moreover, the patient is liable to catch cold, from an accidental wetting; for, in the case of the knee and ankle at least, it is almost impossible to confine the water within the trough. With ice, everything can be kept perfectly dry, by enclosing the ice in gutta-percha bags, and by adopting the additional precaution of covering the wound with a large sheet of the same material, to prevent any accidental escape of water from reaching it. Were it even possible, however, to use irrigation without wetting the wound and surrounding skin, ice would nevertheless be preferable, on account of the lower temperature produced by it. When some of my cases were under treatment, the supply of ice several times became exhausted, and during these intervals the joints had to be kept cool by irrigation, which was never adequate to prevent a rise in temperature, and an

increase of pain. Re-application of ice always reduced the former and removed the latter.

The semi-anæsthesia produced by ice is generally sufficient to remove the pain until suppuration sets in; afterwards, its influence in that respect is not so decided. In order, however, to keep the patient at perfect ease, the bag must be promptly re-filled as soon as the ice has melted; for, unless an equable low temperature be preserved, pain is not completely removed. In some cases it is even increased, and possibly this may, to some extent, explain the difficulty with which ice is borne by some patients of irritable temperament. The low temperature, so far from being hostile to the nutrient changes requisite for primary union, is, through its power of preventing inflammation, one of the best aids to primary union that can be adopted. During the late campaign in Schleswig-Holstein, the surgeons of both armies applied ice to all wounded joints, and to nearly every stump after amputation; and the general conclusion arrived at was, that where it was employed, primary union was more frequent and more extensive, and that the ensuing suppuration was always less. These results ensued whether the ice was applied only until the commencement of inflammation, as practised by Langenbeck; or when it was kept applied until the wound had almost entirely healed by the second intention, as recommended by Esmarck. The practice of continuing the application of cold after inflammation has set in, has generally been considered a dangerous one by the surgeons of this country; but, contrary to what might have been anticipated, the cases treated on the principles of Esmarck succeeded almost as well as those where Langenbeck's practice was adopted.

That treatment by ice is not always sufficient to prevent inflammation, even in those cases where the wound is incised and clean, is evident from what takes place in patients who are of an unhealthy constitution. In them the inflammation progresses rapidly, notwithstanding the local means used for subduing it. It would, however, be worth while to investigate, whether or not a lower temperature than that produced

by ice might not advantageously be employed in some cases where the tendency to inflammation is unusually decided, either from constitutional peculiarity or the nature of the wound. We do not as yet know the lowest temperature at which a part of the body in a normal state may be kept by *dry* cold, without serious interference with its nutrition; still less do we know to what depth of temperature a wounded part may be safely lowered. Should it be found that a lower temperature than that produced by ice can be borne, its production could be effected without much difficulty by the employment of various frigorific mixtures, graduated according to the temperature required. These could without difficulty be prevented from coming in contact with the wound, by enclosing them in thick gutta-percha bags, and by laying a sufficiently large sheet of the same material between the bag and the wounded part. In applying ice to a wound, common bladders ought never to be used if gutta-percha can be obtained, as they very soon allow the water to ooze through, and, notwithstanding the low temperature, soon undergo decomposition. Moreover, gutta-percha is cheaper, and bags can be made very easily, by simply wetting the margins of the pieces to be joined together with chloroform, and holding them in apposition until they dry. In the removal of loose cartilages from the knee-joint, by subcutaneous or direct free incision, I have found that ice constantly applied to the part after the operation until all tendency to inflammation had ceased, was of great service in helping to ward off the serious consequences which have so frequently followed these operations.

If, after applying cold constantly to the part, we find that the disease progresses—if the joint continues to swell, and suppuration is threatened, we must first apply warm anodyne fomentations, and afterwards, if necessary, make free incisions around the joint wherever matter has formed. Poultices should then be applied, or folds of lint moistened with tepid water containing a small proportion of tincture of iodine or of Condy's fluid, and the limb must be kept in a state of perfect repose. In

these obstinate cases, we generally find that there is some degree of ulceration in the cartilages of the joint.

When the suppuration is extensive, either in idiopathic or traumatic inflammation of a joint, we must look for a cure by anchylosis—that is, by a firm union, either osseous or fibrous, of the opposed surfaces of the bones. When we look at a joint where suppuration has occurred, and where the cartilage gradually sloughs off, we find the surfaces of the inflamed bones exposed. If these be allowed to strike against each other they become sources of increased irritation, and, therefore, of increased irritative fever; but if they be kept in accurate position with each other and at perfect rest, then new bone is thrown out from their opposed surfaces, by means of which they gradually unite. The vessels pass from the Haversian structure of the one part to that of the other, and the two bones become anchylosed, or, as it were, welded together, so as to form one. This may occur in either chronic or acute disease, and need not be despaired of even when the symptoms appear to be at the worst, and when all the textures seem to be disorganised from the amount of suppuration.

Anchylosis, as a result of injury or disease of a joint, may be either fibrous or osseous. Partial or fibrous anchylosis is comparatively common, and is most usually met with in cases in which the cure has been accomplished in the earlier stages of joint-disease. In such cases the osseous surfaces are not united, except perhaps at one or two points—sometimes not at all. This anchylosis results from shortening and thickening of the ligamentous textures, and adhesions between the fibrous texture, which takes the place of the cartilages on the articular surfaces, whilst the synovial sac is obliterated and the synovial membrane altered in structure.

True complete or osseous anchylosis, as already described, con-consists in osseous union of the articular ends of the bones forming the joint, which are then firmly welded together in a close unyielding mass as one bone. It occurs after injuries of joints, or in cases of disease, where the cartilages have been rapidly absorbed and the exposed articular surfaces kept in apposi-

tion during the cure. Osseous anchylosis is considered by some to be a very rare occurrence; but though much less frequent than fibrous anchylosis, it is by no means uncommon. I have met with a great many cases in practice; and in my own private collection I have numerous specimens of very complete osseous anchylosis of almost every joint in the body, including the knee, hip, ankle, elbow, and vertebræ—the shoulder and wrist being the only joints of which I do not possess specimens.

Although in some respects anchylosis is considered a favourable result in cases of injury or disease of joints, as regards the cessation of the constitutional symptoms; and, though in many cases our treatment is directed to procure this result; yet, unless under certain circumstances, anchylosis cannot be considered absolutely favourable, as it often leaves a useless, or worse than useless, limb. In injury or disease of the knee-joint, for example, if by careful treatment we succeed in obtaining firm anchylosis in the straight position, then the result is favourable, as the limb, though not capable of performing all the natural movements, gradually becomes very useful. On the other hand, in cases where a joint becomes anchylosed at an inconvenient angle, the limb is rendered useless, and if it be the lower limb it is an encumbrance. In such cases the surgeon requires to interfere to remedy the deformity resulting from the anchylosis. In cases such as that of the elbow-joint, excision, removing considerable portions of the articular ends of the bones so as to form a new movable joint, is decidedly the proper treatment. If the operation be properly performed, and first passive and then gradually active motion be judiciously persisted in, the result will be exceedingly favourable, and the arm will become almost as useful as ever. In the lower extremity, however, say at the knee, a movable joint after excision does not prove useful, and hence the treatment is generally directed to obtain straightening of the limb, and a stiff joint. The methods of treatment adopted for this purpose are various. In cases where the deformity is recent, and the anchylosis fibrous, gradual extension by means of the screw-lever splint (Fig. 2, Plate xx.), or the wire-splint gradually

straightened, either with or without division of any contracted tendons, will generally prove sufficient, and if the disease has not been extensive, some of the natural motions of the joint may even be restored. In cases of firm osseous anchylosis such treatment would be useless. Hitherto the methods generally adopted have been either to break up the anchylosis by forcible extension, after division of contracted tendons, or to perform resection by removing a wedge-shaped portion of the anchylosed bones, so as to enable us to place the parts in the straight position, the after-treatment being the same as after excision of the knee.

I have in several cases had recourse to the former method successfully, but it is excessively rough surgery, and not unattended by danger. We must recollect that if there has been much irritation of surrounding tissues, the great vessels behind the knee-joint may have become locally diseased. At all events, they as well as the tendons have become contracted and adherent, accommodating themselves to the new position of parts. Hence their coats may suffer from the sudden forcible extension necessary to break up the anchylosis. This is no imaginary danger, for I have known of subacute gangrene following such extension. Again, in young persons, instead of the osseous union breaking up, the force often separates the epiphysis of the tibia, and the limb, though straightened, remains somewhat deformed. The resection of a wedge-shaped portion of the anchylosed bones, though free from the dangers alluded to, is a serious operation, being a form of excision of the knee-joint. Dr. Gross of Philadelphia, the son of Professor Gross of that city, employs a procedure which, in suitable cases, is both simple and efficient. Instead of forcibly breaking up the anchylosed knee-joint, he makes a subcutaneous incision, and then, by means of a drill, cuts through the osseous union so far that the remainder yields to very slight force. The incision is then closed, and the limb treated in the straight position, division of contracted tendons being had recourse to if necessary. I can understand many cases in which

it would be difficult to carry out this plan ; but certainly the drilling operation, combined if necessary with the use of a fine saw, is in my opinion much preferable to forcible extension.

Of course, in all cases of anchylosed knee-joint, neither forcible extension nor Dr. Gross's method is permissible or warrantable until all diseased action has ceased for some time. To interfere when there is pain in the joint, or shortly after active disease has been arrested, would be simply to re-excite it under very unfavourable conditions.

Hydrops articuli, or dropsy of the joint, is another morbid condition which sometimes results from inflammation of the synovial membrane, although it is said occasionally to arise independently of such action. The effusion which is thrown out at first continues, the synovial fluid is more serous than natural, and the whole joint is distended. There is not much pain, however, because the ligamentous and other textures have yielded gradually, and are passively distended by the increasing quantity of the fluid. The amount of secretion varies ; at times undergoing absorption when the patient is quiet, and rapidly accumulating again under any irritation. This condition of the joint is very troublesome. Sometimes it is simply the part of the synovial sac under the aponeurosis of the quadriceps extensor which has become distended. The movements of the limb are not then so much interfered with. When, however, the disease has existed for any length of time, the whole articular cavity becomes distended, and disorganisation of a slow character takes place.

The first thing to be aimed at in the treatment of this disease is to get rid of the chronic effusion. One cause of the dropsy probably is effusion from the congested vessels. This takes place very rapidly, and is prevented from being absorbed by the thickening and altered condition of the synovial membrane. To meet these conditions we apply blisters over the affected joint. We also give internal remedies, such as iodine or mercury. These serve to cause disintegration and absorption, and excite a more healthy action ; or, according to the old notion, restore

the balance between the exhalants and the absorbents. The limb must of course be kept at perfect rest, and should also be bandaged from the foot or hand upwards, which further helps the process of absorption. In many cases the tendency to the return of the effusion is very great, the disease being cured for the time only. When this treatment fails to cure the disease effectually, we must then adopt more active measures. We must tap the joint and inject iodine into it, as in hydrocele. This mode of treatment, however, is not unattended with a considerable amount of danger. In many cases no bad symptoms may follow ; but in others, violent inflammation and suppuration are the result. When we simply puncture the joint and draw off the fluid, the danger is perhaps greater than when we also inject iodine. The iodine excites a healthy form of inflammation, and prevents the formation of purulent matter in the synovial sac. It seems to possess an antipyogenic power. In the slighter cases we are not warranted in having recourse to this treatment, but only in such as have resisted the ordinary measures. Internal remedies are also to be given, and the state of the constitution attended to.

Movable Cartilages in Joints are met with occasionally. The general symptoms are very similar to those of subacute or chronic synovitis. There is pain, with more or less fluid swelling of the joint. When the knee is affected, the patient probably at first experiences in walking or in taking a sudden step, a feeling of excessive pain in the joint. This is sometimes so severe as to cause him to fall. This symptom is due to the loose cartilage having slipped between the condyles of the femur and the head of the tibia. In other cases the pain is not so marked ; but the patient can generally tell when the cartilage gets between the ends of the bones. When the joint is much swollen and distended with fluid, it is not always easy to make out the presence of the loose cartilage, especially if it be small and flat. Should there be any difficulty, it is best to keep the patient quiet for a few days until some of the effusion has become absorbed, and then examine the joint. The cartilage

may be either completely loose, or fixed by a long narrow pedicle. If it be quite loose, it will be felt sometimes at one side of the joint, sometimes at the other; at one time above the condyles of the femur, at another over the head of the tibia. The patient can generally find out the position of the cartilage sooner than the surgeon can, from the sensation which he has of its position. When the cartilage is small it is sometimes very difficult to ascertain its presence.

There is another disease which may be mistaken for loose cartilage. I refer to disorganisation of a slow character in the knee-joint, leading to destruction of the attachments of the semilunar cartilages. These cartilages, when so loosened, glide backwards and forwards, and catch the patient while walking. Hence the symptoms are almost identical with those of the ordinary movable cartilage; but the treatment, as we shall see, is different.

The Treatment of movable cartilages is either palliative or radical. The former consists in bandaging the limb, and applying means of retention, such as the laced knee-cap with pads, to fix the joint and prevent the cartilage from getting in between the ends of the bones. When so protected the patient can generally go about in comparative comfort, and without any swelling of the knee taking place. The radical treatment consists in removing the loose cartilage, either by a free incision made upon it through the skin, fascial and synovial textures, or by subcutaneous incision. In the latter method, a tenotomy knife is introduced some distance from where the cartilage is held firmly fixed, then the edge is turned so as to cut down upon the loose cartilage. The cellular tissue in its neighbourhood is separated so as to make a sort of cavity into which the cartilage can be carried. It is left there, and the wound closed. If the cartilage afterwards give rise to any irritation, it can be cut down upon and removed from the cavity in the cellular tissue. If not, it is left alone. Some apply blisters over it, so as to cause consolidation. This method of operating always seemed to me to be incomplete. What good does it do to leave the cartilage in

the cellular tissue? Why not extract it completely when cutting down upon it? The plan of cutting down upon the cartilage and removing it has no disadvantages which the other has not, and is much simpler. With due care no air can enter the wound, and no source of irritation is left, and I have repeatedly operated in this last mentioned way with success. At the same time, there is no class of operations that I have a greater dread of than the apparently simple one of removing a loose cartilage. The case may go on most favourably, and then, when the patient is almost well, inflammation and suppuration may set in, and amputation be ultimately required. Mr. Liston, I know, had a great dislike to such operations; he always recommended the palliative treatment instead. The operation itself is a very simple one; but still I would always try the palliative method before removing the cartilage. In the subcutaneous method of operating we must be sure that the cartilage is quite loose and not attached by a pedicle.

In the affection of the semilunar cartilages before mentioned, the palliative treatment, by fixing the joint and giving rest, is the only one that can be had recourse to; and in many cases of movable cartilage also, the palliative treatment is perhaps the best.

LECTURE XLII.

Diseases of Joints continued—Chronic Strumous Disease or Gelatinous Degeneration. Frequency during the period of Youth. Mildness of its Earlier compared with its Later Symptoms. Local and Constitutional effects. Its general Pathology and Treatment. Its Complications, and the considerations which should influence our Treatment in connection with them.

THE term WHITE SWELLING was formerly used to express all joint-diseases of a chronic character. It is now understood to denote a constitutional form of disease affecting the synovial membranes, to which we give the name of GELATINOUS DEGENERATION, or FUNGUS ARTICULI. This diseased condition occurs almost always in the young; seldom, if ever, for the first time, above middle age. In those cases, therefore, where it does occur in advanced life, we generally find that there has been a similar attack in early youth. The disease may assume the chronic character from the very commencement, in which case its onset is very insidious, and the symptoms are slight and vague. Or it may follow immediately on an acute attack, in which case the symptoms undergo a marked alteration in character. The swelling becomes less diffuse and more bulging ; and, although elastic, becomes gradually more boggy to the feel. The pain becomes greatly diminished, and the symptomatic fever gradually lessens.

Gelatinous Degeneration may attack any joint in the body, but those most frequently affected by it are, the knee, the elbow, and ankle. I shall therefore take the knee-joint as an illustration, and the low chronic form of the disease, as it is by far the most common.

For the first month or so the patient occasionally complains of a very slight degree of pain or uneasiness, he is a little lame, or rather awkward in his gait, from an instinctive desire to save the limb. The pain gradually increases, especially towards night,

and becomes more distinctly localised, the patient generally referring it to one particular spot in the joint. At length we are consulted for its relief, and on examination—say six weeks after the commencement of the disease—we find a partial swelling on either side of the patella, and extending towards the posterior aspect of the lateral ligaments. This increases around the patella, and the markings of the bone are gradually lost in it. The swelling presents either a peculiar elastic or a doughy feeling. The enlargement seems greater than it really is, owing to the emaciation of the limb, for even at an early stage of the disease the thigh and leg of the affected limb become perceptibly atrophied. As the disease goes on, the symptoms become more marked. The colourless swelling increases, the joint becomes more tense and has a glazed appearance. The patella is somewhat raised, though not so much as in synovitis, and the general appearance of the joint bears a close resemblance to what we see in that disease. The pain is not aggravated by pressure on the part; but movement of the limb causes an increase of it, more especially if in doing so the articular surfaces are pressed against each other. The lateral ligaments after a time yield, the swelling becomes more general than in synovitis, and the surface is marked by superficial veins, which become prominently enlarged and conspicuous. The whole joint becomes altered in consequence of disorganisation of its fibrous textures, and the limb becomes rapidly atrophied. As the disease advances, abscesses begin to form in the surrounding parts, and then pain, sometimes severe, is felt in the swollen joint itself. At a further stage of the disease the pain in the joint becomes very acute, and different in character. At night it becomes extreme, and there are spasms and startings in the limb, from an uncontrollable convulsive movement of the muscles, so that the patient cannot sleep. Thus his strength becomes exhausted, his appetite fails, his general health breaks down, and severe irritative fever, tending towards hectic, sets in. The acute pain at night, together with the spasms, are met with in another affection of the joints—namely, in acute ulceration of the cartilages;

but in that disease they occur at a much earlier stage of its progress.

The pathological condition leading to these symptoms consists in a peculiar degeneration of the synovial membrane. This exists under two forms, and these have been described under two separate names—the gelatinous and pulpy degeneration—but they are truly identical in symptoms, and as regards the essential nature and course of the disease. In the gelatinous degeneration as first specially described by Sir B. Brodie, all the cartilages of incrustation become gradually covered over by masses of new deposition, which extend wherever there is synovial membrane. In the recent state this deposit has a gluey or jelly-like character, varying in colour from pale yellow to dark brown, and is generally intersected by lines of a white membranous structure. This is the more general character of gelatinous disease, but there is another condition, in which the membrane assumes a sort of granular or fungoid appearance on the surface; this has been described as pulpy degeneration; but all the phenomena are the same as in the former case, and there is no use in making a distinction between the two conditions. The deposit fills up the whole joint, and acts as a kind of soft cushion, protecting the ends of the bones, so that at first, when the swelling is most marked, there is comparatively little pain. As the disease goes on, however, it leads to a low form of suppuration in the surrounding textures, and induces irritative fever. While the suppuration progresses, we find other changes taking place. The cartilage begins to undergo absorption, either from the pressure of the new deposit upon its surface, or from a peculiar action which the deposited substance exerts upon it. The absorption arises chiefly, I believe, from the pressure on the surface of the cartilage leading to its ulceration and exfoliation, and we can thus easily understand why it is that in the later stages of gelatinous degeneration we meet with symptoms exactly like those of acute ulceration of cartilage. In both cases, the cartilage of incrustation is separated, and the opposite surfaces of the inflamed bones come into contact with each other, giving rise to pain and

starting whenever the opposed surfaces touch one another. It is, in fact, really ulceration of the cartilage, but arising in a different way from what is generally understood by that term. In gelatinous degeneration of a joint, all the textures are ultimately involved; not only the synovial membrane and the cartilage, but also the fibrous textures and the cellular tissue. This gives rise to disorganisation and the formation of abscesses and sinuses in all directions. (Plate xi. Fig. 4.)

The atrophy of the muscles may arise in two ways, either from disuse of the limb or from some peculiar change in its muscular texture. At one time the former view was held, but in a great many cases of synovial and other diseases of joints we find that the limb affected is always atrophied, and that when the diseased condition is so far got rid of, and the patient able to move about, whilst the healthy limb regains its normal state, the affected one never does so completely. This is due to the fact that the muscles of the affected limb have undergone a fatty degeneration, so that the atrophy arises partly at least from a positive alteration in the structure of the muscles. Although the joint usually affected is the knee, yet the disease is not uncommon in the ankle and elbow. The ankle-joint is that in which I would have most hesitation in having recourse to operative procedure, because I have seen many remarkable recoveries from disease of this joint in young children, even where suppuration and ulceration had taken place. In the elbow gelatinous degeneration also occurs frequently, but I cannot recollect of having seen a case of this synovial degeneration in the shoulder-joint.

We now come to consider the *Treatment* of gelatinous degeneration. At one time the disease was considered incurable. Sir Benjamin Brodie held that it was the most incurable of all joint-diseases, and that, sooner or later, the patient either had to undergo amputation or died. On the other hand, Mr. Scott affirmed that the disease was always curable by his plan of treatment, which consisted principally in rest and graduated pressure on the joint by plasters, together with proper

nutrition. The truth lies between these two extreme statements. A very large proportion of cases, especially where the disease is situated in the knee-joint, require amputation or excision sooner or later; but at the same time it is equally true that many cases can be cured by milder measures, if we see them at an early period, and if the patient can be kept under treatment for a sufficient length of time. And so it happens, that in the upper classes we do not so frequently require to perform amputation for gelatinous disease, as we have to do in hospital practice, where the patient cannot be kept long enough under treatment. A patient not unfrequently is dismissed from hospital cured, but owing to his poverty he is obliged to return to his work. By too early and frequent use of the limb, and insufficient nutrition, too great a strain is put upon an originally feeble constitution, and so the disease is reproduced.

In the treatment of this disease, rest is indispensable in every stage. The limb should be placed in the position in which it will be most useful to the patient afterwards. In the lower extremity the limb is kept perfectly straight, or nearly so. If it be partially bent, it should be put up in a wire splint, so formed as to suit the angle of the limb; then, by gradually straightening the splint and the knee together, we bring the latter straight by degrees. If the swelling be white and colourless, as it generally is, we must examine to see whether there be any heat of skin, for the inflammation is deep-seated, and there may be no redness on the surface. If we find that the temperature is greater than that of the corresponding healthy joint, then we must apply tepid solutions of acetate of lead, and morphia, to allay the irritation. This treatment should be kept up for some time; the limb being at the same time bandaged from the foot upwards, and thin strips of lint or cotton, soaked in the solution, brought over the knee-joint, in the form of a many-tailed bandage, so as to give support to and exert a moderate degree of pressure on the joint. This pressure may be increased from time to time as the patient can bear it without much pain, but if it be not done gradually, it will give rise to an increase of the excited action.

In gelatinous degeneration a certain amount of synovial effusion may be present, and we may be tempted to apply a blister at an early stage to cause absorption, but it is very likely to excite too much action, and do harm. A blister should not be applied till the increased temperature has become reduced, but after that it may be of considerable service. When the blister has healed, support by bandaging should be resumed, and occasionally the surface may be painted over with iodine, in order to keep up gently the deobstruent action. Subsequently we may begin what is called the plaster-treatment, which was first adopted by Mr. Scott. This consists in bandaging from the foot upwards to near the knee, as we have already indicated, and then applying broad strips of adhesive plaster round the joint. The ends of the plaster should be made to cross over the joint for some distance, and each layer made to overlap the preceding one to two-thirds of its width. The plasters should be made to extend well up the thigh, and then the bandage from the leg continued upwards over it. The limb is then slung in a splint, and the plaster left on for a few weeks without being removed. In some cases, medicated plasters, such as the Emplastrum ammoniaci cum hydrargyro, are used, but I have found that the irritation of the skin produced by them is often so great as to excite too much action, causing vesications on the limb, and hence leading to its being disturbed too soon. I therefore prefer the simple adhesive plaster, which is generally quite sufficient to stimulate to absorption of the exudation, though in some cases of a more chronic character the medicated plasters may be useful. By keeping the limb at perfect rest in the above way, by giving nourishing diet, and by attending to the patient's general health, we may, in a very large proportion of cases, get rid of the diseased condition, but great care must be taken that the affected limb be not used for some time. Should abscesses form about the joint, they must be evacuated in the manner advised for opening chronic abscesses. In the upper extremity, at a comparatively early stage of synovial disease, the question of excision of the joint comes before us, and this is

often the best method of treatment; for an anchylosed joint in the upper extremity leaves a comparatively useless arm—certainly a much less useful one than remains after the joint has been excised. In the arm we can get rid of all the diseased parts without much shock to the patient's general health. In the knee-joint also it is well not to wait too long before operating, for when abscesses begin to form round the joint, the case is less favourable; and so, when there is much disorganisation of the articular textures, we operate before the patient's health has suffered much. I believe that most cases of gelatinous degeneration in the knee are not well suited for excision. The operation does not seem to me to answer so well here as in some diseases of the articular ends of the bones; in most cases the general health of the patient is not so well suited for the operation, which requires considerable strength and involves a long period of convalescence. Moreover, I have found that even cases where excision of the elbow or wrist joints has been performed for gelatinous disease never go on so favourably as cases where the operation has been performed for what looks like more extensive disease. This form of diseased action seems to be of a low type, and connected with a very marked strumous diathesis, and the curative process seems to be very slow; hence, besides the risks of pyæmia incidental to all operations in debilitated constitutions, it is often complicated with pre-existing disease of other organs, or a predisposition to diseased conditions, which are very liable to develop themselves during the progress of the disease, or after operations, such as excision or amputation performed for its removal. The complications most frequently met with are—disease of the lungs, kidneys, and occasionally, though much more rarely, disease of the membranes of the brain, or tubercle in the brain-substance. In drawing attention to such complications, I do not mention them as contraindicating operative procedure, but because I believe that by careful attention to the state of such patients, we may often be enabled to check the development of some of the conditions mentioned, when they arise during the after-treatment

of cases which have been operated on. Again, by careful examination of the general health of such patients, we will often, by delaying operation and preparing them, give our operations a better chance of success; and we will also be guided as to the nature of the operation to be performed—as, for example, in deciding between excision or amputation. In regard to disease of the lungs, unless the disease be far advanced, we ought, as a general rule, to operate. I believe that the joint-disease is a source of great irritation and debility, and that by amputation we relieve the patient of a diseased condition, procure rest, allow nutrition to be carried on, and so arrest, or at least palliate, the lung-disease. I have so frequently seen consumptive patients, who were suffering from gelatinous degeneration of the knee, regain strength and flesh, with marked amelioration of the chest-symptoms, after an operation, that, as I have said, unless the disease be very far advanced, I never hesitate to give the patient the chance afforded by amputation, and the recoveries in such cases from the operation are usually very rapid. As to the dread which formerly existed, that the local disease acted as a sort of counter-irritant, and that its removal would be followed by more rapid development of the disease of the lungs, I can only say, that after a very considerable experience in such cases, I have always found amputation followed by amelioration, not exacerbation, of the chest-affection. I recollect one patient, a man who had suffered from tubercular phthisis for several years, who came under my care; he had cavities in the apices of both lungs, and occasional smart hæmoptysis. Besides examining the chest myself, I had him carefully examined by the physicians of the hospital, who agreed with me in thinking that the advanced stage of the chest-disease, and his extreme debility, contraindicated operation, and I declined to accede to his request to amputate the limb. He left, and went to another hospital near his home, where he induced the surgeon to take off his limb; and eight months afterwards, he presented himself to me, looking in pretty good condition, and, as he said, with less cough and spitting of blood; and he lived for two or three

years afterwards, showing how much relief may be afforded, even under unfavourable circumstances, by removal of a painful and debilitating local affection. It is necessary, however, to remember that, notwithstanding the advantages which often result to consumptive patients suffering from gelatinous disease, still there are many cases in which it would be wrong to amputate the limb unless the patient's health be pretty good so as to bear the protracted after-treatment.

The diseased condition, however, of which I have greatest dread in connection with gelatinous degeneration, is one which is also to be met with in certain forms of scrofulous necrosis, but I have specially noted it in relation to gelatinous degeneration. I allude to disease of the kidneys, and as it is a complication which may not attract attention till too late, I would seek to impress you with the necessity for great care, not only in the examination of patients prior to operations, but during the progress of the after-treatment. Not unfrequently all seems going on well, the wound heals, and perhaps the only thing noticeable is that the pulse does not come down in frequency, or at least is variable. Some weeks after, when the patient seems convalescent, the appetite begins to fail, and a little irritation and swelling arises in the part operated on, which was healed, or all but healed. The parts are œdematous, and the lower limbs are also in the same condition. The urine is probably now examined, and on being tested is found highly albuminous, and the case soon terminates fatally. I have long made it a rule, when a patient of marked strumous diathesis comes under my care with joint-disease, or disease of bone, to test the urine, and to have it tested from time to time, at least every second or third day, both prior to the operation and during after-treatment; for often, where there is no trace of albumen or unhealthy condition of the urine at first, these conditions may afterwards develop themselves rather suddenly. There are, however, other symptoms in such cases, which, if attended to, indicate, I think, this tendency; at least, from my own observation, I am always very suspicious when the skin is dry and harsh to the feel, the pulse quick or

variable. Very specially when, during the treatment of such cases, we notice the tongue to be red and glazed, or worse, if it presents the appearance as if little patches of the epithelium had peeled off, ought we to dread the occurrence of renal disease. I have so frequently seen cases in which the urine was healthy, so far as the evidence of tests was concerned, but in which, after a few days a form of subacute albuminuria occurred, with ultimately fatal results, that I cannot forbear dwelling, it may appear tediously, on this subject, because I believe careful treatment might at first obviate this condition, or prevent it from progressing if early looked for and detected.

In such cases the diseased condition of the kidney is generally found to be either the amyloid degeneration or an acute congested state of the organ—the latter state probably supervening rapidly in an organ predisposed to disease. The state of the urine in the latter case is somewhat peculiar—its specific density often remaining normal 1020, whilst it is highly coagulable. From what I have seen of cases in which this complication has arisen, I believe if the condition be suspected and detected early, that, by the use of sinapisms, or cataplasms containing mustard, the exhibition of mild diluent diuretics, and the use of farinaceous instead of more stimulating diet for a short time, the acute or subacute congestion of the kidneys may be arrested. This will be shown by the subsidence of œdema, the diminution of albumen in the urine, and by the tongue resuming its normal appearance. In some cases, at the very commencement of this condition, I have occasionally found benefit from the use of small eliminative doses of colchicum wine; and in all cases the use of diaphoretics, to cause a moderate increase of the cutaneous transpiration, are of great use in relieving the irritation of the kidney. After a short time, if the œdema continues, the use of the muriated tincture of iron, combined with nitrous æther, will be found the most efficacious remedy. If, however, the diseased action has gained head before being noticed, the result is almost always fatal. Whilst this tendency to renal disease is met with in cases after amputation, I think that it is still more

likely to be developed after operations, such as excision of the knee, where the after-treatment is protracted ; and, as I have said, I have even seen it occur after excision of the elbow in cases of gelatinous degeneration. I confess that this consideration would weigh with me in deciding between amputation and excision.

As regards the general treatment of Gelatinous Degeneration, chalybeates, which are of use in all scrofulous diseases, are especially useful here, and cod-liver oil is one of the best nutrients in this form of disease. It requires much care and experience to know when to give stimulants, and when to avoid them, during certain stages of the diseased action. When it is assuming a subacute type, before suppuration has begun, then stimulants are often injurious ; but when suppuration has commenced, or when the irritative fever is considerable, the use of stimulants is distinctly indicated.

LECTURE XLIII.

Ulceration of Cartilage—The Characters, Symptoms, Progress, and Pathology of the Disease—Distinctions between Ulceration of Articular Cartilage and Gelatinous Degeneration—Primary and Secondary Affections of Cartilage: Danger of confounding them with Disease of Osseous Textures—Aids to Diagnosis—Morbus Coxarius: its Manifestations, Progress, Diagnosis, and Pathology.

The cartilage of incrustation, although an organised structure, is endowed with but feeble vitality, and is thus all the more liable to become affected by disease. It is of a firm, durable consistence, by which property it is well fitted to protect the articular surfaces from the tear and wear of ordinary action. It has an elasticity which adapts it for meeting the contingencies arising from concussion, and its surface is smoothly polished so as to lessen friction and ease the motions of the joint. In its intimate structure it is destitute of nerves and bloodvessels, and it therefore possesses little vitality and no sensibility. Thus, it is admirably adapted for its functions, which are chiefly of a protective kind, and for which the simple qualities of resistance and endurance are mainly requisite. What little nutrition is required for the maintenance of such a low type of structure, the cartilage derives second-hand by imbibition from the tissues in its neighbourhood; and on the integrity of these, therefore, does its soundness depend, so that when they are involved in disease the cartilage is apt to become implicated secondarily. Sometimes, however, the cartilage is the seat of the primary affection, when it becomes diseased independently of the neighbouring textures.

Ulceration of the cartilage was described as a special form of disease by Sir Benjamin Brodie, though it was formerly known by the general term of white swelling, one of the stages of which it was supposed to be. Brodie pointed out that there were

marked differences in the symptomatology of the two diseases in the earlier stages—the one being characterised by pain on being pressed in certain directions, while the other is painless; and the one being generally marked by a greater amount of swelling than the other.

Any joint may be affected by this disease, but those most commonly attacked are, the hip, knee, shoulder, and elbow joints. The ankle is sometimes affected with it, but not so often as with gelatinous degeneration. One difference between this disease and gelatinous degeneration is, that in the former the patient feels pain and uneasiness at night at a very early period, leading to want of sleep and startings in the limb. The pain is generally of a subacute character, and the patient instinctively avoids resting any weight upon the limb. The nature and locality of the disease may be often ascertained by the attitude the patient assumes. When the hip-joint is affected, he bends the knee somewhat, and rests upon the opposite limb. When the knee-joint is the seat of disease, the limb is always bent, the thigh being flexed upon the pelvis, and the leg upon the femur, so that the articular surfaces of the bones are separated, and prevented from pressing against each other.

In the very early stage of ulceration of cartilage there is not much swelling, though even then there may be some effusion into the joint, and there may be a certain amount of irritation from affection of the synovial membrane. As a rule, this is not the case as it is in gelatinous degeneration, and if there be any swelling it is noticed in the ends of the bones, the markings of which are not lost as in other joint-diseases. In the case of the knee-joint the head of the tibia appears larger than usual, and all the bones concerned are enlarged to a certain extent. This enlargement appears to be greater than it really is, owing to the atrophy of the muscles, and these become atrophied at a very early period.

In this, as in the foregoing disease, we shall take the knee-joint as an example. On examining the joint, if we press on either side of the patella, we produce no pain; the patient says

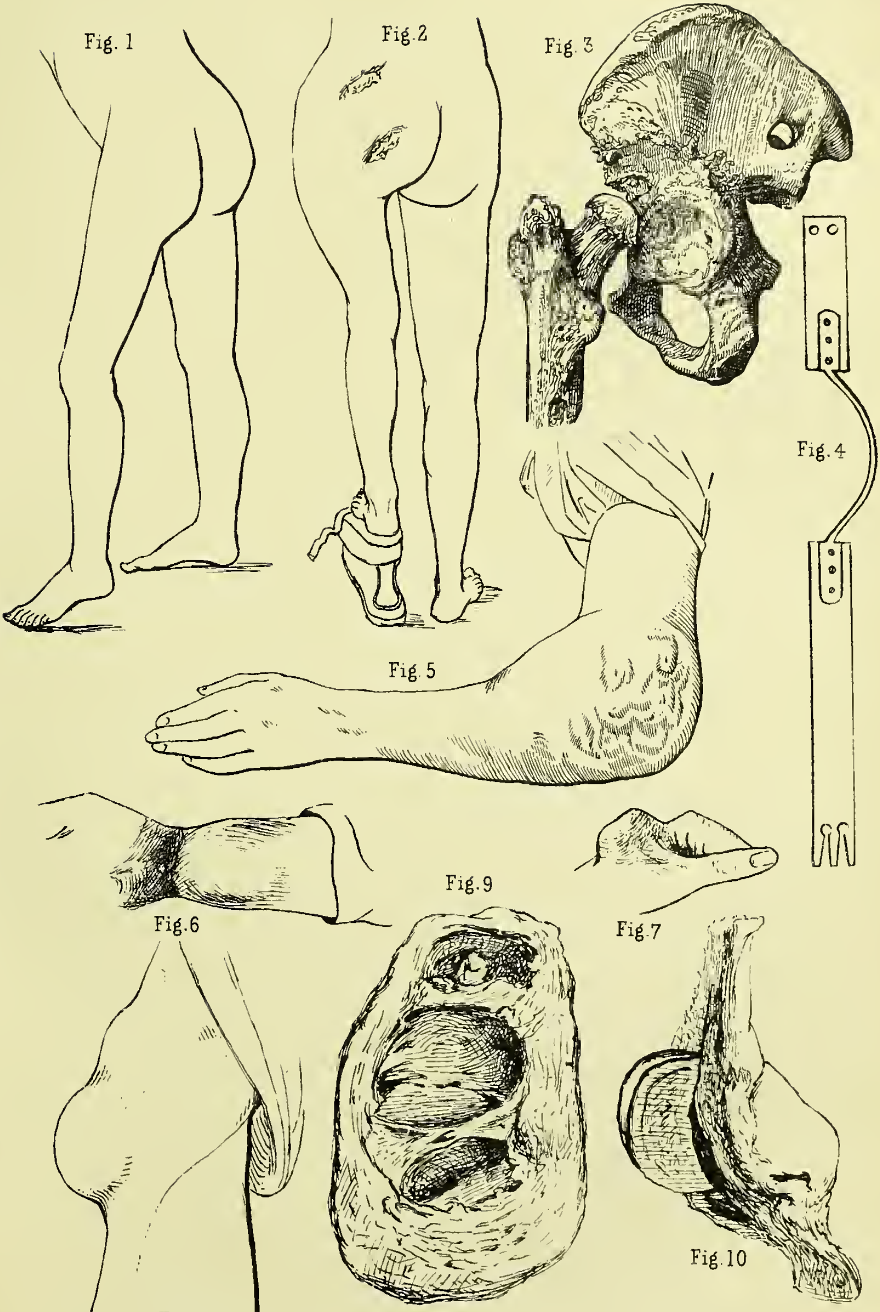
he feels little or no uneasiness during the greater part of the day, provided that the limb be kept at rest, but that uneasiness and pain are experienced at night after getting warm in bed, and sometimes during the day immediately after taking food. These pains, at first of a dull rheumatic kind, become by-and-by more persistent and acute, and the knee becomes gradually more and more bent, owing to the efforts on the part of the patient to avoid making any pressure on the articular surfaces of the bones. The pain is accompanied or followed by swelling of a subacute inflammatory form ; at first within, but ultimately around, the joint. By-and-by unhealthy strumous abscesses form in the neighbourhood, which may afterwards communicate with the articular cavity. In the secondary stage the pain is not only intense, but is more or less continuous, and is increased on moving the limb or applying the slightest degree of pressure, and then the symptoms come on which are peculiar to the disease. Whenever the patient goes to bed and begins to fall asleep, he is roused by a sudden and convulsive jerking of the limb. This destroys his rest for the greater part of the night ; but towards morning he doses over into an apparently tranquil slumber, from which, when he awakes, instead of being refreshed he is much exhausted. Under this extended ordeal of suffering his general health rapidly gives way, and he is reduced to the extremity of weakness and emaciation.

Sir Benjamin Brodie showed that these symptoms corresponded to those of the third stage of gelatinous degeneration, when absorption of the cartilages takes place. The jerkings of the limb arise in consequence of the contact between the exposed surfaces of the diseased bones. In ulceration of cartilage, as we have shown, these symptoms come on at a much earlier period than in gelatinous degeneration. The symptoms of ulceration of cartilage are so severe, in contrast with those of the earlier stages of gelatinous degeneration, that we would conclude the extreme pain to be due to the affection of the cartilage itself. This idea, however, is opposed to what we know of the intimate structure of cartilage, which possesses no nerves or vessels in its texture.

How, then, is the disease attended with such extreme pain? It has been shown that cartilage suffers from inflammation indirectly. We find that, when cartilage undergoes alteration and absorption, the process may occur in two ways. It may commence within the cartilage itself, and then it takes place more or less slowly. The cartilage breaks down and its place is taken by a soft fibrous texture which covers the ends of the bones, and this is effected without much pain—just what we might naturally expect from the nature of cartilage. Thus true ulceration of cartilage is not necessarily connected with disease of bone, but the diseased condition generally spoken of as acute ulceration of cartilage I believe to belong to another texture altogether; it is, in fact, one of the symptoms of scrofulous inflammation of the articular ends of the bones, leading to articular caries. The articular ends of the bones are very vascular, and the cartilage is nourished from them; hence, in the earlier stages of the disease, we have swelling of the ends of the bones. There is no pain produced by making lateral pressure, but intense pain is experienced when we apply force directly upon the opposed surfaces of the bones, even though they are still covered by cartilage, because the bone underlying the cartilage is affected with a low subacute form of inflammation. The patient does not complain of much pain in the earlier stage of the disease, but then he keeps the joint bent, and the opposed surfaces of the affected bones as far away from each other as possible, so as to prevent their contact. As the disease goes on—as the ends of the bones inflame—the swelling of the joint becomes more marked, and the atrophy of the muscles becomes more evident. This corresponds to the period when the disease is at its worst. There is extreme excited action, and pain, and suppuration within the joint, and then the startings of the limb are induced, because, in many of these cases, the cartilage is thrown off in large exfoliations.

This I believe to be the true pathology of what is termed ulceration of cartilage; it is a disease not commencing in the cartilage itself, but that structure becomes affected from its connection with the bone. A low form of inflammation of the bone

Plate XIII



takes place, and exudation is gradually thrown out between it and the cartilage. The nutrition of the cartilage is thus interrupted, and at last it ulcerates and exfoliates. Subsequently when the opposed surfaces of the inflamed bones come into contact, excruciating pain is the result.

We see, therefore, that ulceration of cartilage may take place in two ways: either spontaneously, from changes within itself, in which case it is attended with no pain; or it may arise adventitiously, from inflammation of the bone beneath it, and then it is attended with acute pain. In the former case the disease progresses slowly, but in the latter the ulceration goes on rapidly. The pain in ulceration of cartilage, as distinguished from that in gelatinous degeneration, is almost invariably dependent on disease or change in the osseous structure, leading to ulceration or exfoliation of the cartilage, and so causing exposure of the inflamed bones (Fig. 3, Plate xi.)

As another example, let us take Morbus Coxarius, or disease of the hip-joint. This disease almost always occurs before the age of thirty, generally in early childhood. It may pass off at that time, and then recur when the patient is advanced in life. On examining the patient we find that, on the affected side, the limb is somewhat everted, and that the fold of the nates passes obliquely downwards, giving the hip a flattened appearance. (Fig. 1, Plate xiii.) The patient stands with the knee projecting forwards, and with the body stooping somewhat, so that the affected limb looks longer than the other. There may be some slight real lengthening of the limb, but the apparent lengthening is generally due to loss of power in the muscles, by reason of which they allow the hip to droop. It may also be, in part, due to the position which the patient instinctively assumes in order to prevent the head of the femur touching the acetabulum. If we ask the patient whether he feels much pain, he answers no, except at night, or when walking. At these times he feels pain, not in the hip itself, but on the inner side of the knee. This pain is very often of an intense character, so much so that, in a great many cases of hip-joint disease, we find that the patient has been

treated for disease of the knee, by blisters, warm fomentations, splints, and the cautery. If we touch the knee, the patient complains of pain; but if the femur be fixed, and then the heel pressed upon, so as to cause pressure on the knee-joint, there is little uneasiness produced. The pain is neuralgic in its character, and sometimes extends to the outer side of the joint, but generally resides in the filaments of nerves on the inner side. If there be swelling about the knee, it is sometimes rather difficult to tell whether or not that joint is itself affected with disease; but on viewing the hip we can readily perceive that the disease is situated there, from the peculiar atrophied and flattened appearance of the nates. If the limb be rotated outwards, some slight pain is felt, so also when the limb is flexed; but if we press directly inwards upon the trochanter, and rotate the foot, the patient complains of excessive pain, which becomes greater as the pressure is increased, and this pain is felt even at an early stage of the disease.

There is a low form of strumous inflammation of bone, leading to scrofulous caries, and this condition exists for some time without the cartilage being thrown off. Gradually, however, the patient goes on from bad to worse: the limb, instead of being longer than the other, becomes shortened, though this may not be very noticeable at first. Abscesses may form round the hip, either at an early stage or not until the last stage. The limb is sometimes much bent and drawn up, and the foot turned in. There is a slight projection of the trochanter major and an atrophied appearance of the hip behind. The shortening of the limb increases, and sometimes the thigh is flexed at nearly a right angle with the body. These changes go on till dislocation of the head of the bone occurs. In the later stages we find the inflammation taking place in the surrounding textures; abscesses form in the neighbourhood of the hip, which require to be opened.* Great irritation arises in front of the limb, and, in some cases, it is attended with enlargement of the glands. Abscesses sometimes form in the perineum, which may burst through into

* Plate xiii. Fig. 2.

the rectum, or in the female, into the vagina. The general health of the patient is, of course, much deranged from the irritative and hectic fever accompanying the disease. In the first stage there is simply the atrophy of the muscles, and a low form of inflammation in the acetabulum and head of the femur. The cartilages on both surfaces of bone are for a time unaffected. They remain as a protection, to a certain extent, until the diseased action in the bone leads to their ulceration and exfoliation. Coincidently with that occurs suppuration within and around the joint. The changes which the bone undergoes lead to dislocation. We may have a positive dislocation of the head of the femur on the dorsum of the ilium as a consequence of disorganisation of the capsule of the joint. This is not common ; the fact is, that the appearances resembling dislocation on the dorsum of the ilium are most frequently caused by changes in the form of the head of the femur and of the acetabulum. The head of the femur may become absorbed to a great extent, and the muscles, by acting on it, may give rise to the appearance of dislocation.* The acetabulum may suffer to a much greater extent than the head of the bone, which then sinks deeper in, and in this case we often meet with abscesses opening into the anus or vagina. The pus formed in the acetabulum bursts through into the pelvis, making its way through the obturator internus and obturator fascia, and appears by the side of the rectum. In other cases the head of the femur may be locked in the acetabulum from deposit of new bone round the margins of the cavity, and yet the appearances may be those of dislocation. There is no doubt that sometimes dislocation of the head of the femur really does take place, but generally the appearance of dislocation is caused by the head of the femur lying deeply in the acetabulum, or sometimes even in the pelvis, when it has broken through the acetabulum into that cavity.

* Plate xiii. Fig. 3.

LECTURE XLIV.

Treatment of Morbus Coxarius, as exemplifying the treatment of ulceration of cartilage in general—Question of excision and amputation of different joints—Chronic Rheumatic Arthritis; its history, pathology, and treatment—Hysterical affections of joints.

In Morbus Coxarius, as in all other joint-diseases, the first and most important part of the local treatment consists in securing perfect rest of the affected joint. When the hip-joint is affected, that object must be attained by keeping the patient in the recumbent position, and the long splint must be applied so as to fix the movements of the trunk, and also of the knee and ankle joints. For this purpose I generally employ the bracketed splint shown in Fig. 4, Plate xiii., as it prevents pressure on the affected part and permits the use of local applications. The rest must be maintained for at least six or seven weeks, perhaps much longer, for in many cases the splint requires to be persistently retained for eight or nine weeks. If any local irritation exists, it should be soothed by the application of warm or anodyne fomentations; and by these means, together with those which are necessary for the restoration of the general health, and which consist in the administration of good nourishing diet, cod-liver oil, and occasional tonics such as quinine or chalybeates, we may, in a great many cases, cure the disease in the earlier stage without any further treatment. The great disadvantage in the use of the long splint is, that it interferes injuriously with the general health of the patient by preventing him from getting plenty of fresh air, and at least passive exercise. Still, in the earlier stage of the disease, the risk from the patient's being confined to bed is less than that which would arise from using greater freedom. In order to compensate for the wants just indicated, the bedroom must of course be well ventilated, and

after about five or six weeks the patient may be taken out into the open air in a carriage, and thus allowed the benefit of passive exercise while the joint is still maintained at rest. In some cases, after five or six weeks, we use a starch bandage from the foot upwards round the pelvis and hip. This, from its rigidity, prevents to a great extent the movements of the hip; but in hospital practice, the long splint, in a modified form, is more simple. Amongst the poorer classes, the results of treatment are less favourable than those which are obtained amongst the middle and upper classes. A patient cannot be kept in hospital till the disease is thoroughly cured, for that would require about a year or eighteen months. Besides, the patients are seldom brought to the hospital in the earlier stage of the disease, or indeed before deformity and shortening take place; and when the disease has been allowed to go on so far as this, the splint alone is not likely to do much good.

If the pain in the joint should increase, we must have recourse to still more active remedies, such as counter-irritation, and by far the best method of producing this, in connection with deeply-seated diseases of bone, is by the application of the actual cautery. If this be done behind the great trochanter, it will often be the means of arresting the disease even when it has passed beyond the first stage, and when ulceration of the cartilage has begun. If abscesses form, they must be opened; but the patient generally sinks when there is much suppuration, and if he recover, it is only with a greatly deformed limb.

In other joints, before this stage is arrived at, amputation of the limb, or excision of the joint, should be performed; but in the hip it is different. The question in all cases of excision is—Can we remove the whole of the disease? In the shoulder-joint, the head of the humerus and the glenoid cavity can be completely removed, so that all the disease can be got rid of, and so also in the elbow and knee joints; but in the hip-joint it is of no use to excise the head of the femur and leave the acetabulum which is also diseased. Then comes the question—Can we excise the acetabulum? In some cases with a gouge we may re-

move a considerable part of it when diseased; and therefore, in certain cases of morbus coxarius, I can see no harm in cutting down upon the joint, removing the head of the femur, and then, if necessary, scooping out part of the acetabulum. But before attempting to excise the joint, we should first try a careful and prolonged treatment, as before described. Some surgeons advocate amputation at the hip in cases of morbus coxarius, but I do not think it is to be advised, although some successful cases are recorded by Mr. Holmes; it is perhaps even less warrantable, except under special circumstances, than excision of the head of the bone.

In the shoulder-joint the operation of excision should be performed early, because then the muscles are little altered, and the whole of the diseased textures can be readily removed. Here it is principally the head of the humerus that is affected, and not so much the glenoid cavity. In fact, I have never had to remove the whole of the glenoid cavity for the disease, but only parts of it. A very useful limb is left after excision of the shoulder-joint.

In the elbow-joint there can be no doubt as to the propriety of early interference, because we thus save the patient's strength and obtain a more useful limb than would result from anchylosis; this applies also to the shoulder-joint. In the wrist the joint should also be excised early, and a very useful hand will generally be left.

In the knee-joint the question arises, whether an anchylosed knee after long treatment is better than a knee after excision of the joint. If the diseased action be pretty extensive over the surface of the joint, and if there be great local pain and irritation from that source, and the ends of the bones evidently much affected, then, if the patient's health has not suffered very much, and if the constitution be not very irritable, excision of the joint is the proper treatment. In other cases, where there is much suppuration round the joint, and where there is gelatinous degeneration present, excision of the joint is not so suitable. I think that those cases where the diseased action in the knee is

well marked, and limited to the bone, without much suppuration, and where the general health has not suffered much, are better suited for excision than those cases in which there is an unhealthy condition of the synovial membrane. The most successful cases I have had have been in young females under thirty, where the general health has not been much affected, but where the local disease was very great. In male patients again, the results have not been so successful, though why it is so is not very clear. It is not every case of diseased knee-joint that is suited for excision; but in properly chosen cases, the operation is likely to be successful. Were it done in all cases in which amputation used to be performed, we would find that the statistics of excision would be much less favourable than those of amputation. When we contrast the amputations performed for disease of the knee-joint with excisions for the same disease, we find, as a general rule, that the former are much more successful—the deaths from amputations being 1 in 7, those after excision 1 in 3 or 4.

Excision of the knee-joint is an admirable operation in many cases, but if we wish to preserve its character we must take great care to ascertain the cases best suited for its performance.

In disease of the ankle-joint excision is not often required, for even after suppuration and great disorganisation of textures has occurred, we often find that by persistent constitutional treatment, and with perfect rest, a cure will be accomplished by anchylosis. In the wrist-joint, in a great many cases, especially in adults, amputation of the forearm is to be preferred to excision of the joint. But if we see the patient early in a case of acute ulceration of cartilage, excision should be performed, for though it be a far more difficult and tedious operation, it leaves a very useful hand. When the parts are much disorganised, amputation must be performed. In two cases of gelatinous degeneration, for which I performed the operation of excision at an early period, though both did well for some time, yet they afterwards required amputation. The state of the constitution attendant on gelatinous degeneration is not so favourable as that met with in other

joint-diseases for operations requiring a long period of convalescence.

In all cases of diseased joints, when the patient is very much exhausted, when hectic fever has come on, and when all means have been tried to save the limb, then amputation must be performed, and it is well not to let the patient's health sink too far before operating. In the knee the disease should not be allowed to go on till abscesses have formed all round it, as the operation will be much less likely to prove successful then than if done before, and the risk of pyæmia will be much greater. If we require to amputate where chronic abscesses are present, they should not be opened till the operation is performed, and then they should be freely opened, and painted afterwards with the tincture of iodine. If they are opened beforehand, irritative fever is often the result, and will, of course, tell very much against the operation afterwards.

There is a disease of the hip resembling morbus coxarius in some of its characters, and which has been sometimes confounded with it, but which seldom arises until the patient is considerably above forty years of age, while morbus coxarius generally occurs in childhood.

The disease I refer to is Chronic Rheumatic Arthritis of the hip-joint. This has been described under a variety of names. If the patient has been seen early, and the fibrous and synovial structures chiefly examined, the disease is named after some change in them. If the osseous textures are examined, it receives its name from changes in them. It has been termed "interstitial absorption of the neck of the femur," because the neck of that bone becomes so shortened as almost to lie below the level of the trochanter. And it has been called "porcellaneous disease" on account of the peculiar alterations which take place in the texture of the bone. The cancellated portion seems to be first opened out and then to become dense again, so that there are large foramina left on the surface. Then, wherever the cartilage has been absorbed, the articular surface of the bone is noticed to be covered with a sort of china-

like deposit, of a glistening smooth appearance and great hardness. This causes the movements between the opposite surfaces to take place with a peculiar creaking noise. From its appearance and qualities it has been called the porcellaneous deposit, hence the disease has been termed "porcellaneous disease" of the joint.

These terms express only parts of one diseased action: the alterations described do take place; but they are changes going on from one structure to another, and we require to look at all the textures in studying the disease. We find that both the acetabulum and the head of the femur become altered in form; the cotyloid ligament running round the margin of the cavity is filled with earthy deposit, so as to become almost ossified. The bone itself is denser, and the cartilage is absorbed, its place being taken up by fibrous texture, throughout which we see the porcellaneous deposit appearing. Projecting from the synovial membrane are a variety of small fimbriated structures which pass into the openings of the cavities, or enlarged Haversian apertures seen in the bone. These fimbriæ are highly vascular. Every texture in the joint is affected, the fibrous being perhaps those first affected. The disease is a rheumatic one, and comes on very slowly in after-life, and in patients whose general health is otherwise good, and who have usually much muscular power.

The history of the disease is somewhat as follows:—Towards night the patient feels great pain of a rheumatic character about the hip and the knee joints. The pain ceases in the day-time, and recurs at night. The patient probably takes medicines, which give relief for a time, but some exposure to damp or cold brings with it a return of the symptoms. By-and-by he begins to experience a sense of lameness; he cannot walk erect as formerly, nor bear any weight on the limb, and there is some swelling and deformity beginning to present itself, together with a corresponding degree of stiffness, so that the patient cannot flex the joint, and cannot go up and down stairs as formerly. This arises from the progressing changes, which are taking place in the joint and in the fibrous textures surrounding the aceta-

bulum. The limb becomes much altered, the foot and knee are everted, and the limb shortened. The appearance presented is very like what occurs in fracture of the neck of the femur, for which accident it may be mistaken; but in this disease the symptoms result from alterations in the head of the femur. In chronic rheumatic arthritis the general health of the patient is seldom or never affected. There is atrophy of the hip to a certain extent, but not nearly so much as in morbus coxarius. The alteration which takes place is, in fact, not so much due to atrophy as to an altered line of the muscular fibre, which gives rise to an appearance of it. Instead of the limb being wasted below, as in morbus coxarius, we find that the calf of the leg is preternaturally developed.

Treatment of chronic rheumatic arthritis.—In the earlier stages, depletion by cupping, keeping the patient quiet, and the use of colchicum, will do a great deal to prevent the disease from going further. If, however, it still goes on, the actual cautery and the long-continued use of the iodide of potassium are the best methods of preventing the structural changes from taking place; but as the pain only comes now and then, the patient is seldom treated persistently. The disease is met with in persons of rheumatic habit. The diseased action is, therefore, not to be classed with morbus coxarius; it is simply a rheumatic affection requiring persistent treatment. In many of these cases the use of the warm douche and salt-water bathing is beneficial—warm bathing being generally the best. Preparations of sulphur may also be given with advantage, but the iodide of potassium is a much more efficient remedy than any of the more popular ones. The disease attacks the knee, elbow, and shoulder-joints, as well as the hip. It is pretty frequent in the shoulder, and sometimes leads there to most serious consequences.

A very acute form of disease of the hip, attended with local and general symptoms not unlike those of acute ostitis, is occasionally met with. It seems to be dependent upon acute inflammation of the bone and periosteum. In most cases which have come under my notice the pelvic bones seem to have been

affected in the first instance, leading to ulceration of the cartilage of the acetabulum, and thus producing acute disease of the hip-joint. The amount of irritative fever attendant on it is very considerable, and is often of the typhoid type, as in acute necrosis.

It may arise in scrofulous and rheumatic patients, from exposure to either cold or damp, and I have seen it follow upon uterine irritation, either from operation on, or exploration of that organ. From the acuteness and urgency of the symptoms these cases are attended with great anxiety.

The general treatment, although more active, must be conducted on the same principles as guide us in the treatment of acute ostitis and morbus coxarius.

Attention was first directed to HYSTERICAL AFFECTIONS OF JOINTS by Sir Benjamin Brodie, who stated that they were a frequent source of wrong diagnosis, and in that way often led to very serious results. The joints most commonly affected with it are the hip and knee. The symptoms simulate those of almost all articular diseases. It generally occurs in females, or in males who are otherwise in weak health. The symptoms are the same as those of disease of a joint—the pain is extreme, there is sleeplessness at night, and jerkings of the limb, the patient is unable to bear any pressure on or movement of the limb, but there is no apparent swelling. It is sometimes very difficult to arrive at a correct diagnosis, especially if, as often happens, remedies, such as fomentations and blisters, have been applied previously to relieve pain, and have caused a certain amount of swelling and stiffness in the joint. The patient has a quick pulse, an irritable tongue, and often an anæmic appearance. She complains of excessive pain, which is increased at night. On making an examination we cannot feel much swelling in the joint, though we may find a slight degree of effusion into it. From the similarity of the symptoms to those of joint-disease, the diagnosis is very difficult, and operations have sometimes been performed for what is really a neuralgic affection, under the belief that the joint was diseased. We may, however, find both hysterical affection and the incipient joint-disease existing

at the same time. A good test to find out whether joint-disease really is present, is to press heavily upon the joint, and not touch it lightly. If the joint be not affected, the patient will complain of no pain, while, if there be any articular disease, the pain will be great on pressure. Then to try and examine the patient when she is off her guard. Much care and experience are required in diagnosing such cases. We should never be in too great a hurry to operate, when there is any doubt as to the real nature of the disease.

As regards the treatment of hysterical disease of joints, the warm or cold douche is very beneficial, and internally, chalybeate tonics are the best medicines.

LECTURE XLV.

Various forms of Bursæ—Acute and Chronic Bursites and their treatment—Special organic alterations in Bursæ and the treatment adopted to these—Solidification of Patellar Bursæ, and operations for their removal—Thecal Bursites, acute and chronic—Bursal swelling at wrist containing loose bodies—Special treatment.

NEARLY akin to diseases of the joints proper are those affections in which the *bursæ mucosæ* are involved. We shall, therefore, consider the diseases of bursæ before entering on the subject of fractures and dislocations.

Bursæ are met with in various parts of the body. They are sometimes placed deeply, in situations where muscles or tendons glide over each other or over the osseous structures underneath, and sometimes subcutaneously, where they are interposed between the skin and prominences of bone. The texture in the interior of the bursa is like that of the synovial structure; it is perfectly smooth, and secretes a small quantity of fluid. Normally, the bursa is composed of a very delicate texture, and around it, and forming its covering or capsule, is fibrous tissue. If we take the bursa met with over the patella as an example, we find the sac to be pretty regular in form, with a thin fibrous texture forming its outer covering, and lined by a fine, smooth, synovial structure, which secretes a fluid like synovia, but somewhat more limpid. The object of the bursa is to allow of free movement between the surface of the patella and the textures which pass in front of it, and also between the tendon and the skin. In other cases a bursa lies between strong muscular fibres or the aponeurotic texture lining muscles, or over the tuberosities of bones near articulations, such as the great trochanter of the femur. Thecal bursæ are also met with, arranged along the sheaths of tendons in an elongated form, as at the wrist-joint,

where they extend for a considerable distance along the flexor tendons, and so allow of very free movement. The uses of bursæ are so obvious that we need hardly allude to them. We often find bursæ being formed adventitiously where more than usual pressure or movement takes place, as in talipes varus or club-foot, where bursæ form, sometimes of a large size, so as to obviate the effects of constant friction, and the weight of the body, on a part of the foot not intended to bear pressure. Ganglion is the name given to an adventitious bursa arising under such circumstances. Ganglia are most frequently met with amongst the extensor tendons on the posterior aspect of the wrist, and result from continuous use of the fingers, as in playing the piano, drawing, and knitting. The distended thecal bursæ, situated amongst the common flexor tendons in front of the wrist, do not belong to this class. They arise from an affection of the proper sheath of the tendons. (Plate xiii. Fig. 7.)

Bursæ, like other textures, are liable to inflammation, which may be either acute or chronic—generally chronic, although in the more exposed bursæ, such as that over the patella, often of the acute form.

In Acute Bursitis the symptoms are as follow :—The position of the bursa becomes marked by a tense rounded swelling which suddenly arises. This is accompanied by pain, redness on the surface, and much stiffness of the joint. The swelling conveys to the touch a feeling of distinct fluctuation, and the patient begins to suffer from symptomatic fever. There is increased secretion of fluid, causing increase in the size of the swelling ; the fluid becomes vitiated in character, and very soon has a tendency to become purulent. At first there can be no difficulty in the diagnosis of the disease, but, as it progresses, the decided diagnostic symptoms become less noticeable, and very speedily—often in less than a couple of days—the whole limb swells from the inflammation. The vessels relieve themselves into the cellular tissue, giving rise to acute œdema of the surrounding textures, with erythematous inflammation spreading from the site of the bursa ; and the case might now be mistaken

for erysipelas of the thigh or leg. There may also be a difficulty in distinguishing it from disease of the knee-joint, as the swelling is not defined, but the fluid is superficial to the patella or ligamentum patellæ, and does not therefore correspond to the fluid within the synovial sac. In the patellar bursa, however, the symptoms of acute bursitis are perhaps more marked than in any other.

The *Treatment* is very simple. Absolute rest, with the limb in a straight position, is essential, as in all affections of joints. Leeches and warm fomentations should be applied over the inflamed bursa. These remedies, if employed early, will very often arrest the inflammatory action, and cause the disease to terminate by resolution. If the diseased condition should continue, we must take measures to obviate the effusion into the surrounding tissues, and localise the inflammation as much as possible. When the symptoms have become more marked, the patient may have a rigor, which affords an indication that suppuration has begun. The fluid is still confined within and distends the sac, the sooner, therefore, the bursa is opened the better. There is a difficulty, of course, as to the absolute diagnostic symptom of matter being present in the sac, in consequence of fluctuation being present from the very first; but when the symptoms increase in intensity, and rigors come on, the bursa should be opened, for even if pus has not fairly formed, we generally find that a large quantity of vitiated bursal fluid is got rid of, and the disease is cut short more easily. Hence we ought never to hesitate, in cases of acute bursitis over the patella, or wherever the bursa is superficial, to treat it in this way. When the bursa is deeply seated, we require to act with more caution, for we may have to deal with inflammation of the joint as well as with acute bursitis, and the swelling may be caused by disease of the joint, or by the formation of abscesses within it, and so the diagnosis becomes more difficult. But in all cases, the presence of acute pain, tension, and suppuration, indicate that we should make a free incision, and let out the matter. In cases of acute bursitis over the patella, we sometimes meet with abscess stretching up the thigh and down the leg.

This must be treated as diffuse suppuration arising from any other cause would be—namely, by being early and freely opened. When opening a suppurating bursa, it is sometimes as well to make a lateral incision, besides a free central one, so as to let the matter drain off more readily. The after-treatment is conducted in the same way as that of an ordinary abscess, by either poulticing or water-dressing, as occasion may require.

CHRONIC BURSITIS arises in general from continued pressure on, or movements of, the part. The so-called "housemaid's knee"* is an example of it, and arises from kneeling constantly. In chronic bursitis, the pain is not so great as in the acute form. There is stiffness in movement, and a gradually increasing swelling, which at last becomes very prominent, and prevents the patient from going about. The *Treatment* of chronic bursitis will depend very much on the condition of the bursa. If the disease be seen in the early stage, before much change has taken place, and when as yet there is only thickening of the external fibrous capsule, and a larger amount of fluid than usual has been secreted from its smooth internal surface, then the ordinary plan of treatment will suffice. This consists in keeping the limb at rest, and applying a blister, so as to excite action and cause absorption. These results are further favoured by painting over the surface with iodine, and bandaging. In a very large number of cases we will succeed in curing the disease by such means, more particularly if they are followed up, on the part of the patient, by the avoiding of pressure and any other of the originating causes.

In other cases, however, we find that whilst the swelling is not very large, and can be got rid of at the time, yet it returns very rapidly so soon as the patient goes about again, and subsides when he remains at rest. These phenomena give indications of conditions very different from those described. They tell of more extensive organic changes. The interior lining membrane undergoes alteration in structure. It becomes fimbriated, and projecting across it at intervals are to be found fibrous bands. Not unfrequently it contains a quantity of

* Plate xiii. Fig. 8.

loose movable bodies of different sizes. Thus we find that not only is the natural surface in a state of inflammation, but there is really an altered structure, and therefore the ordinary plan of treatment will not effect a permanent cure. Rest is, of course, essential. An incision should be made into the tumour, the fluid evacuated, and all the loose movable bodies removed. The surface of the sac should then be painted over with strong tincture of iodine. When the tumour is smaller in size, and its contents completely fluid—that is, when no foreign bodies can be felt in it—we may treat it as already indicated, or we may use the trocar and canula, as in hydrocele, to draw off all the fluid, and then inject the iodine. There is not the same danger in injecting iodine into a bursa as into a joint. When the bursa is not very large, the best plan is, I think, to make a free longitudinal incision, and then paint the interior of the sac with iodine, and afterwards bandage the limb from the foot upwards. If the tumour be large, and no foreign bodies can be felt in it, the treatment by the trocar and canula will answer better.

The disease may go on to other changes. The fibrous texture often becomes enormously thickened, and the cavity diminished in proportion. The external texture becomes dense, and fibrous bands project across the interior.* This thickening process goes on till the tumour becomes almost or altogether solid. It then contracts slightly in bulk. Under these circumstances, the simplest plan of treatment is excision of the solid mass. An incision should be made longitudinally over the tumour and the solidified bursæ, together with any adherent skin, dissected out. There is no risk incurred in the operation. If we are afraid of injuring the patella or the capsule of the joint, we can leave a thin portion of the fibrous texture behind. There is no chance of a return of the tumour, as there would be if it were malignant. Excision is the only method of treatment applicable to these growths when they become solid or nearly so. Injecting iodine would do little good ; it might obliterate the cavity, but would leave the solid part unaffected.

The tumour, instead of becoming entirely solid, may present

* Plate xiii. Figs. 9 and 10.

a large fungating mass on the surface, which looks like a malignant growth, but is really ulceration of the bursa. In one case lately under my care the bursa over the patella was filled with a bloody grumous fluid like that of hæmatocele. This is called hæmatocele of the patellar bursa, but it is a very rare form of disease.

The bursitis of thecal bursæ is subacute or chronic in form. It occurs often after exposure to cold or wet. It is generally met with in the tendons of the peronei and tibialis posticus about the ankle. There is pain in the tendons, and also a peculiar creaking noise when they are moved. This is partly due to a subacute form of rheumatic affection of the fibrous texture of the sheath, with effusion between it and the tendon. The creaking sensation is owing to friction between the surfaces roughened by exudation. At the wrist-joint, after frequent attacks of this diseased condition, we have the thecal bursa investing the flexor tendons becoming affected. The effusion begins to assume a chronic form, and is more or less constantly present, interfering with the movements of flexion and extension. There is a distinct swelling in the central part of the forearm near the wrist, which seems to stop suddenly where the flexor muscles terminate in their tendons. In the palm of the hand there is also a fulness, though less noticeable. This is due to the thick palmar fascia not allowing the projection of the fluid so much as the thinner fascia in the forearm does. On pressing the swelling in the forearm, the palmar fulness increases, whilst the indentation at the wrist becomes more marked. The indentation at the wrist is caused by the strong annular ligament forming a constriction there. (Plate xiii. Fig. 6.)

In thecal bursitis the ordinary plans of treatment may be had recourse to, and will generally cure the disease if applied in the early stages. After a time there is always more or less swelling, which returns whenever the hand is moved. This is generally due to a number of disc-like bodies and loose fibro-cartilages which form in the thecal bursa. The deobstruent remedies, which are useful in the other forms of bursitis, are of no use here. By using them we may get rid of the fluid, but not

of the solid bodies. There is, therefore, only one efficacious plan of treatment—namely, to make an opening into the swelling and remove the loose bodies. In performing the operation, an incision is first made through the central line of the swelling above the wrist, and the upper cavity completely emptied. The finger or a director is then passed down in front of the tendons till the annular ligament is felt. Under this we glide a probe-pointed bistoury, and divide the constriction subcutaneously without injuring the skin of the palm. The contents of the palmar portion of the sac can then be easily pressed out through the upper opening. The surface is then lightly painted over with iodine, which prevents too much suppuration from taking place, and also greatly facilitates the cure. Subsequently warm-water dressings are applied, and the hand and wrist bandaged. The patient must be made to move his fingers slightly, so as to prevent adhesions from taking place between the tendons and their sheaths. In this way the disease is completely got rid of; but such treatment is only to be adopted when the case has resisted the other methods before spoken of.

The ganglia or adventitious bursæ vary in size and in consistency.* If they are very small, they often disappear without any treatment. Formerly, blisters and other remedies were applied. If these failed, the patient was made to clench his fingers, and the surgeon tried to burst the ganglion by a hard blow, but this very often failed to effect a cure. Rupture took place only at the weakest point of the bursa, allowing the effusion to escape, but the wound in the cyst healed and fresh effusion was formed. The plan I have found most effectual is to pass a small tenotomy-knife or a large cataract needle obliquely through the skin till the bursal swelling is entered. The point of the instrument is then moved about so as to tear up the wall of the cyst or sac of the bursa in all directions, and so cause sufficient inflammation to produce adhesion, and prevent re-accumulation of effusion. Slight pressure is then to be applied on the part by means of a firm compress and bandage, and the hand kept quiet for some time.

* Plate xiii. Fig. 7.

LECTURE XLVI.

Injuries of Bones and Joints—Definitions of the terms Fracture, Dislocation, Diastasis—Diagnostics of Fracture and Dislocation in general—Classification of Fractures—Simple Fracture—Process of Union—Reduction and Coaptation—Various causes of Displacement—Retentive Apparatus.

Having discussed the diseases of bones and joints, I now proceed to the consideration of the injuries to which they are liable. In treating of fractures and dislocations, whether generally or specially, I make it a rule to treat of them together instead of separately. This at first sight might seem to imply a want of arrangement, but in reality it is the best method, as it enables the teacher to bring more fully before the student the points of similarity and dissimilarity between fractures and dislocations, and by force of contrast to impress them with the importance of the conditions of greatest value in reference to diagnosis and treatment.

A fracture may be defined as a solution of continuity in any bone; a dislocation is an abnormal separation of the articular surfaces of two bones from each other; diastasis is a term used to denote a solution of continuity between the epiphysis and shaft or body of a bone, an accident which occurs in young persons. In all these conditions there is, of course, a displacement, but the term dislocation is in surgery restricted to the displacement of the articular end of a bone from its corresponding cavity or surface.

There are certain general symptoms present in all fractures. First, distortion and shortening of the limb, with some swelling and pain; unnatural mobility at the site of the fracture when the surgeon tries to move the limb; also crepitus, or a peculiar crackling sensation, caused by the opposed surfaces of the broken bone grating upon each other, which is considered as the pecu-

liar diagnostic symptom of fracture. We cannot, however, always trust to this symptom, as in the young, when the bones are not quite ossified, little or no crepitus will be heard or felt.

The symptoms of dislocation or luxation, as compared with those of fracture, are, distortion, as in fracture, owing to displacement of the limb, swelling and pain, the latter being increased on attempting motion. The altered form of the part is caused by the absence of the articular end of the bone from its normal position, and its projection in some abnormal direction. The deformity caused by this is generally greater than in fracture, owing to the larger size of the articular extremities of bones as compared with their shafts. These general symptoms of fracture and dislocation are somewhat in common : distortion, pain, swelling, and deformity, caused by displacement—the character of the deformity being slightly different in the two cases. The absolute differences between luxation and fracture are, absence of crepitus, immobility of the dislocated limb, whether motion be attempted by the patient or surgeon. Thus in the shoulder-joint the arm cannot be moved from the position in which it is fixed, and this used to be stated as the absolute diagnostic between dislocation and fracture. This is not true in every sense, for in certain dislocations there is sometimes abnormal mobility, though not the normal movement of the joint. In these dislocations the parts can be moved in directions where movement could not have been exercised before ; thus, at the elbow, when the joint is dislocated, free lateral movements can be made, which could not have been effected in the normal state of the parts ; but the natural movements of flexion and extension cannot be performed. Still this is no objection to the term immobility being used, for it is used with regard to the natural movement of the joint. In dislocation there may be either lengthening or shortening of the limb, while in fracture, with one or two exceptions, there is always shortening. Such exceptions are certain fractures of the pelvis, and fracture of the trochanter major, where, from the muscles which support the limb losing their attachments, the limb is apparently lengthened

or droops, but in almost all other fractures shortening of the limb occurs.

There are also special symptoms in particular fractures. If the ends of the fractured bone be overriding each other, there will be no crepitus. In fractures of the neck of the femur there is often no crepitus, when the parts are widely separate, and it is only by bringing the ends of the bone into contact that we can elicit it. In dislocation of the humerus it is not uncommon to feel a slight crepitus on moving the limb, owing to the osseous attachments of muscles being partially torn off by the force causing the dislocation, but, as a rule, there is no distinct crepitus in dislocation. Such are the general appearances of, and differences between, fractures and dislocations.

Fractures are divided into several kinds:—

Simple, where the bone is merely broken across transversely or obliquely at one point.

Comminuted, where the bone is broken into fragments.

Compound, where there is a wound caused either by the bone bursting through the soft parts and appearing externally, or caused by the force which produced the fracture wounding the soft parts down to the broken bone. It is, in fact, a wound of the soft parts communicating with the fractured point. The mere existence of a wound in the immediate neighbourhood of a fracture does not necessarily make it a compound fracture, unless the wound communicates more or less directly with the point fractured.

Compound comminuted, where there is a wound communicating with the fractured bone, the bone itself being shattered into fragments.

In simple and in comminuted fractures there is no solution in the continuity of the integument, and no external wound. In the compound and in compound comminuted fractures there is an external wound communicating directly with the fractured bone.

In SIMPLE FRACTURES, as a rule, the injury is caused by the

lowest degree of violence: if the fracture be caused by indirect violence, as by jumping or falling, the injury is at its minimum. Here there is pain and distortion, with a certain amount of swelling if the limb be not speedily adjusted, and crepitus on moving the broken ends of the bone. If such a fracture be left alone, or if the fractured ends of the bone be left without any retentive apparatus, or without being reduced, as in experiments on the lower animals, we see what nature will do to cure the fracture. For a time the movement of the broken fragments gives rise to irritation and spasm, and leads to increased pain and suffering. More swelling takes place because the broken ends of the bone tear the bloodvessels, and blood is effused, and then serous exudation follows. The movements of the muscles become somewhat obstructed by this swelling, and thus a certain amount of rest is as it were enforced. The ends of the bone generally lie at some little distance from each other, with the periosteum torn, and the Haversian structure connecting the periosteum with the interior of the bone also partly torn, and we find a certain amount of bleeding taking place into it. The ends of the bone override or overlap each other, and a large mass of blood is formed round them. A considerable amount of effusion takes place, and plastic material is exuded from the vessels of the Haversian structure, so that after a time a hardened mass surrounds the fracture and keeps the parts somewhat together. This mass is called the "provisional callus," and some believe that it is present in all cases of fracture, and is absolutely necessary to union. They hold that this mass becomes converted into fibrin, which is afterwards ossified, and that so the effused blood-clot comes to be useful in forming bone. My answer to this is, that in a properly set fracture, and one which has been set at once, there is no such provisional callus, and therefore it cannot be essential to the healing of the fracture. The parts are simply brought together; plastic material is thrown out from the Haversian structure, and from the periosteal vessels, and this becomes ossified; but the simple fibrin of the blood-clot is never of any use, and is to be regarded merely as a foreign body,

the less of which we have, the better. Those who hold the former view say that the large osseous mass formed, makes the bone stronger than ever. In such instances, however, it will be found that the apparent thickening of the bone at the point of union, is really due to overlapping of the fractured ends, and that new material is thrown out only to fill up the inequalities. In a properly-set fracture, I repeat, there ought to be little swelling, and no provisional callus. The union of the bone takes place, just as in the soft parts, from the plastic material thrown out between the opposed surfaces. What we see in the case of a fracture in the lower animals, in experiments made on them, is simply the natural process of cure. The blood effused is of use in preventing the action of the muscles, which would otherwise cause further displacement; but the clot is of no use in forming new bone. Some hold that the union of the ends of the bone is due to the clot of blood thrown out between them becoming ossified. They say that the medullary canal becomes re-established, and the circulation is again carried on through it, so that, excepting the thickening at the fractured point, we could tell no alteration in the bone. If, however, we look at a fractured bone, no matter how long after the injury, we see that the medullary canal is never re-established, but that at the fractured point there is always a septum, a line of dense bone, which can in all cases be recognised; the Haversian structure has become condensed and ossified at the fractured point, where the new material was thrown out between the ends of the broken bone.

These considerations are important practically, for if we trust to the provisional callus and a certain amount of swelling being present in all cases, we are very apt to have badly set and imperfectly united fractures. If, on the contrary, we treat the fracture as we do a wound, by keeping the ends of the bone in accurate contact—a slight amount of new matter only being thrown out to unite the bone—we will have well-set and firmly united fractures. The fracture should be set at once, and the fragments kept in position by proper retentive apparatus, and means taken to modify any inflammatory action which may arise.

The reduction of a fracture consists in making extension and counter-extension on the lower and upper parts of the bone, if the ends of the bone are overlapping, until the broken ends of the bone come into contact. Coaptation is the exact fitting of the broken surfaces to each other. When this is effected, the fragments must be kept in position by means of retentive apparatus. In applying this, we must keep in mind to fix the neighbouring articulations as well as the broken ends of the bone, so that no movement can be made which would affect the fractured point. The mechanical retentive apparatus is generally very simple, consisting usually of a wooden or pasteboard splint on either side of the limb, passing from the joint immediately above the fracture to that immediately below it, and retained by slip-knots or a bandage, so as to fix the limb completely. In other cases a pad in certain places is necessary, to prevent the bone being drawn in towards the trunk. In treating a fracture, whether by retentive apparatus, such as splints or bandages, or by attention to the position of the limb, it is most important always to keep in mind what are the displacing causes of the fracture; what are the conditions, whether muscular or otherwise, which led to the displacement originally, which tend to displace the bone after it has been set, and which therefore require to be obviated. Without attending to these points we can never treat a fracture on principle.

The displacing causes vary of course in different cases. In each fracture there are certain particular displacing causes; but there are some which are common to them all, such as the muscular displacing causes, the weight of parts which have lost their support, the force causing the injury, from the direction of that force, and the direction of the obliquity of the surfaces of the bone. In fracture of the surgical neck of the humerus, for example, the upper end of the shaft of the bone is drawn in towards the chest. This is caused by the action of the pectoralis major, the latissimus dorsi, and teres major, the deltoid still further helping to produce this effect. These muscles also draw the lower fragment upwards as well as inwards. The

head of the bone is scarcely at all displaced, for the subscapularis counteracts the effect of the supra- and infra-spinatus and teres major. This is an example of muscular displacing causes. In this case no splint is required; a pad is placed in the axilla, so as to throw out the upper end of the lower portion of the humerus, and the elbow is supported so as to keep the parts in position, the upper arm being at the same time bandaged to the side; and this is all the retentive apparatus required for the treatment of this particular fracture. In fracture of the clavicle at its middle, again, we have an example of muscular and other displacing causes. The outer end of the sternal portion of the bone projects upwards, and is called the "riding" end of the bone, while the acromial end is depressed and the arm falls down. The principal displacing cause here is not muscular, it is simply the weight of the arm and scapula, unsupported by the clavicle, dragging down the acromial end of that bone. At the same time, however, the shoulders are narrowed from side to side, and the elbow tilted outwards, and this is caused by the action of certain muscles; the pectoralis minor, acting on the coracoid process, and also the pectoralis major, draw in the scapula and shoulder, whilst the subclavius, attached to the lower surface of the outer portion of the clavicle, tends to draw it downwards below the inner end of the bone. The displacement of the sternal portion of the clavicle is sometimes attributed to active muscular causes, the outer head of the sterno-mastoid dragging it upwards, and so causing it to project. But this is not the case, because, opposing the sterno-mastoid, and more than counterbalancing its action, are the clavicular fibres of the pectoralis major, which tend to draw the bone in the opposite direction. The sternal portion of the bone is really in its normal position, the outer fragment only being displaced. As a general rule, the fractured bone is more or less influenced by the muscles attached to different parts of it; and, in the femur for example, if it be fractured at one point, the ends of the bone are forced in one direction by the action of certain muscles attached to it, whilst in other fractures, very close to the same part, the ends of the bone are displaced in

different directions from the action of other muscles. In fracture of the neck of the femur the foot has a tendency to fall outwards ; this is not owing merely to active muscular causes, but also to the normal condition, for when a person is lying down the limb falls to the outside naturally ; and in cases of fracture, when the continuity of the bone is broken, the same tendency exists, though somewhat increased by certain muscular causes.

In the general treatment of fracture, the retentive apparatus should be so applied that we can examine the parts from time to time, without displacing the splints or moving the limb. For this purpose the splints are generally put on with a sheet or slip-knots, for if we use the continuous roller, we must undo the whole apparatus whenever we want to examine the limb.

At first the patient should be put on low diet, and opiates and febrifuge remedies administered to allay any pain or fever ; but we should take care not to disturb him much by giving purgatives. We should keep the bowels open by diet rather than by medicine, for any undue moving of the patient is always injurious. After a time we should give better diet than usual ; in some cases stimulants are necessary. Many surgeons adopt the plan of putting up fractures in starch or plaster-of-Paris at first, but I have great objections to this, for when it is used we cannot examine the limb readily when we want to do so. Besides, when we set the limb, and put a starched bandage on it, it fits very well at the time, but as the swelling diminishes the bandage becomes loose, and we cannot tell what is going on beneath. The starch bandage looks very pretty, but when it is taken down we may find that the fracture is by no means so well set as if the more simple apparatus had been employed.

LECTURE XLVII.

Transverse and Oblique Fractures—Comminuted Fracture, dangers, treatment—Compound Fracture—Importance of considering the kind of force causing the Injury—Question of Primary Amputation—Risks of Pyæmia and Gangrene—Question of Secondary Amputation—Complications in Fracture.

If a fracture be transverse, there is very little displacement, and no difficulty in keeping the fragments in position. In oblique fracture, the greater the obliquity of the fracture the greater is the difficulty of treating it. There is a constant tendency for the broken surfaces of the bone to glide upon one another, so that extension and counter-extension are necessary to keep them in accurate contact. Oblique fractures always give great trouble to the surgeon, and require great care and attention in treating them. To keep up a certain amount of extension, and prevent lateral movement, are the general indications of treatment.

In some fractures, as that of the patella, all that need be done is to keep the limb on an inclined plane, and so obviate the displacing causes, and to apply a bandage so as to keep the fragments as close together as possible. In other cases of fracture the double-inclined plane is necessary, but this will be more fully treated of under special fractures.

In the comminuted fracture the bone is broken up into more than one portion. Even in the simple comminuted fracture, where there is no injury of the soft parts, the danger and difficulty in treatment are much greater than in the simple fracture; and the greater the amount of comminution, so much the greater are the dangers and difficulties of the case. When the bone is broken into a number of small fragments, it is very difficult to keep them all exactly in position, or indeed to

get them rightly placed at first, especially when there are any small fragments lying across the direction of the fracture. There are, moreover, dangers in the after-progress of such a fracture, both as regards the limb and otherwise. There is, first, the risk of the irritation produced by the fragments lying between the ends of the bone tearing the muscles and other textures, and so acting as an obstacle to union. Again, portions of the comminuted bone are sometimes so completely detached by the violence of the force causing the injury, that necrosis often follows. When this takes place, inflammation is excited by the dead bone acting as a foreign body, and suppuration sets in, which may lead to serious results, from the long-continued discharge and the difficulty of getting rid of the necrosed bone without interfering too much with the fracture. Where necrosis occurs in this form of fracture, when considerable portions of dead bone are removed, there is of course a loss of substance in the bone, so that extension and counter-extension cannot be well kept up; there must be more or less shortening of the limb, and there is thus a greater risk of deformity after a comminuted than after a simple fracture.

As to the treatment of the simple comminuted fracture. In the slighter cases, there may be no great difficulty in setting the bone properly at first; but if the bone is lying loose, and broken up into minute fragments, we should try to model the limb as near as possible into the natural form. The limb is, therefore, extended and counter-extended; and if there be any portions of bone lying laterally, we must try to bring them into line with the natural axis of the limb. When the limb is thus modelled as much as possible to its natural form, it is then placed in a splint, and here a particular retentive apparatus is applied for each special fracture. In such a fracture, of the leg for example, Liston's splint, or the double-inclined plane, answers best. The thigh and leg are kept nearly at a right angle with each other, the foot being fixed and extended, and the whole is kept in position by slip-knots or a circular bandage. The general modelling of the limb is looked to from time to time; and if there be any

tendency to alteration, small splints are put on laterally, and the case must be watched carefully for some time. If the injury has been caused by great direct violence, there is a greater risk of the fracture becoming a compound comminuted one, by inflammation and suppuration, or by sloughing. As regards the after-treatment of the case, if there be any inflammation, a cold or tepid water cloth is applied on the surface for a time. The splints must be kept carefully applied, and the part left open, so that it may be dressed easily, and in this way, if there be not much fever, comminuted fractures often do very well. In some cases we find that we cannot bring the parts into position so well as we could wish, small pieces of bone slipping out as soon as they are adjusted. When this happens, we should content ourselves with merely maintaining the general position and length of the limb, and not meddle with the parts too much at first, but rather wait for a week or ten days till a certain amount of plastic exudation has been thrown out, and then model the bone properly, for now the exudation will keep the small fragments of bone together. The general position of the limb should never be altered, the two great portions of the bone—the lower and the upper—should be adjusted at once, and always kept in a line with each other; but we should not meddle too much with the intermediate comminuted fragments, as that may cause too great irritation. Opiates should be given to allay the pain, and attention to diet, is essential. In comminuted fracture of the cancellated bones of the foot, the comminution is very great. Suppuration and necrosis of part of the bone very often take place, requiring amputation to be performed, though in some few cases this may not be required.

In compound fracture there are peculiar dangers which must be specially attended to. It may seem strange that a simple wound communicating with the fractured bone should make so much difference, and cause so much danger, but so it is, and even a comparatively slight fracturé communicating with an external wound is always more dangerous than a simple fracture, or a simple comminuted fracture. We must

Plate XIV

FRACTURES

Fig. 1

Fig. 2

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look at the dangers of compound fracture in connection with the fact that the wound communicates directly with the bone, and the nature of the violence causing the injury. If the fracture be caused by direct violence, making a wound down to the bone, we cannot wonder at the danger, for here there is very great force, not only breaking the bone, but also destroying the soft parts covering it, giving the character of a contused wound, and sometimes of a lacerated wound. If the fracture be caused by a sharp instrument, then there is the least amount of danger to the patient, for here there is more the character of an incised wound. Even if a joint be implicated in such a case, the patient may do very well, notwithstanding the important parts injured; but then, from the injury being inflicted by a sharp instrument, directed with great force, the soft parts and the bone are all cut through rather than broken. In cases of compound fracture from a cart-wheel or railway-truck passing over the limb, there is the greatest amount of force causing the injury. The parts are much bruised, and the bone broken up; and even though the fracture be not very severe, the other conditions, the laceration of the nerves and vessels, and of the soft parts generally, will cause great danger. When the fracture is caused by a weight falling on the limb directly, and breaking or bursting through the soft parts, the effects are the same, though not so severe as in the preceding case. Where the fracture is caused by the patient falling or jumping from a height, the bone being projected through the soft parts, we have perhaps the minimum amount of danger. The soft parts are torn through when they are tense, by the sharp end of the bone, so that there is comparatively little bruising or laceration, and often the periosteum is not much torn. As a general rule, cases of this kind present less danger than other compound fractures. In all compound fractures, we must look to the force causing the injury in order to estimate properly the dangers of the case.

In the compound comminuted fracture there is just another danger added from the comminution of the bone, and, generally,

the force causing this injury is very much greater than that causing the more simple fractures. We must not estimate the danger of a compound fracture by the size of the wound accompanying it; the fracture may be very dangerous, and the soft parts around it very much injured, though the external wound be very small. In other cases there may be a very large external wound, and a serious fracture of the bone, which may heal comparatively readily—the very extent of the wounded surface really diminishing some of the dangers by preventing the tension and inflammation which might otherwise arise.

The specialties of treatment in compound fracture are the different forms of apparatus, so applied that the wound may be dressed readily, whilst the fragments of bone are kept constantly in position. In fracture of the leg, for example, it is laid on the double-inclined plane, so that the greater portion of the limb is exposed. The foot, knee, and thigh are fixed, but the whole of the anterior portion of the limb, and both sides of it, are exposed, so that the wound can be very readily dressed. In fractures of the thigh, if the wound be on the outer side of the limb, the two portions of the long splint are connected by an iron hoop over the wound (Plate xiii. Fig. 4). Extension is thus kept up, while the wound can be easily dressed; the splints must of course be altered according to the position of the wound and the site of the fracture. If the wound of the thigh be at the side, we may use the anterior and posterior splints as well as the long splint.

The general symptoms must be carefully attended to. The state of the wound and of the soft parts must be constantly noticed, and care taken that no undue pressure is caused. When the shock of the injury has passed off, we must ascertain the state of the great bloodvessels, to see that there is no interruption to the circulation in the limb. This must be done even in some cases of simple fracture, for an artery may be torn without much effusion of blood at the time. If this has occurred, the parts will become livid, and would soon become gangrenous. A considerable

amount of irritative fever generally follows on the fracture, but this symptom usually passes off. In other cases suppuration and rigors come on; the tongue, however, is not foul, but the rigors become more frequent and pyæmia sets in. This is a condition which is not sufficiently insisted on in surgical works. In deciding on amputation in compound fractures, we are told of gangrene, of necrosis, and of the long continued discharges; but more important than these is the fact that pyæmia may come on, even though the fracture may not seem a very serious one, and when pyæmia does set in we cannot interfere, for amputation then would simply hasten the death of the patient.

In regard to general regimen, we must give non-stimulating diet at first, along with iron and other remedies of that kind, with a view to ward off bad results.

In estimating the question of amputation in compound fracture, we must first consider the possibility or the probability of saving a useful limb, and in this we must be guided by the amount of the comminution of the bone and the injury to the surrounding soft parts. If we require to remove large portions of comminuted bone lying quite separate from the other textures, where there must therefore be much shortening of the limb, should the chief vein or artery be injured, in such a case, even if the limb were saved, its vitality will be much lessened; and sometimes, from the amount of shortening, it will be worse than useless, while in most cases of this kind, the limb, such as it is, will only be saved at great risk to the patient's life. If we consider that the risk to life is greater than the probability of saving a useful limb, we are quite justified in performing amputation; but the amount of force causing the injury must always be kept in mind, in deciding in each case. We should also remember that pyæmia is very apt to supervene, and that the risk to life from this cause is very great, while the chance of saving the limb may be very small. In other instances, the patient may be determined to run considerable risk rather than submit to amputation. In all cases where the upper limb is con-

cerned, we should remember that here the risks are less, the vital powers are greater, the management of such a fracture is easier than in the leg, and the chances of saving the limb are therefore greater. Moreover, if we save the hand and wrist, even though it be deformed, still it is more useful than any artificial limb which can be obtained; while in the lower limb, on the other hand, the risks are greater, and the saved limb may be less useful than an artificial one. The risks of gangrene must be considered in connection with the degree of force causing the injury, and the age and constitution of the patient must also be kept in mind. In old persons, and those in middle life, the chances of success are less than in younger patients, especially those under adult age, who possess greater vitality than older persons. In the young, even though a considerable extent of bone be lost, a large amount of new bone is thrown out, filling up the vacant space, and so leaving a pretty useful limb.

Secondary amputation is sometimes required in compound fracture. Spreading gangrene may necessitate it, but this has been spoken of before under the subject of mortification. Where there is necrosis of the bone, with long-continued suppuration from any cause, when the patient's health is giving way, whenever hectic supervenes, and when the limb would evidently not be a useful one if saved, then secondary amputation ought to be performed. As a general rule, secondary amputations for injury are by no means so successful as primary ones, and hence the necessity for the surgeon making up his mind at first whether to amputate or not. In these cases irritative fever is often present, and this should be considered, as in such cases the stump takes on an unhealthy action and pyæmia is likely to follow. In compound comminuted fracture the rules for amputation are the same, but here we have one advantage over the simple comminuted fracture as regards local treatment, for we can readily remove any loose portions of bone through the wound, and thus often save a very serviceable limb.

As regards the different complications of fractures, it would

be endless to enter on them, for they vary so much. We may have a case where, from the direction of the wound, the limb would require to be kept in one position, and in another position for the union of the fracture. No general rule can be laid down for the treatment of such cases, and each must therefore be treated according to the particular conditions which may be present.

LECTURE XLVIII.

Period at which a Fracture is consolidated—Dangers of using the Limb too soon—Bending of the Injured Bone—This Risk specially great in the Young—Necessity of permitting Passive Motion at an early period in certain Fractures—Failure of Union—Causes, Local and Constitutional—Condition of the Bone in such cases—False Joint, Methods of Treatment—Subcutaneous Section—Seton—Resection—Dieffenbach's Method—Injuries of Texture resulting from Dislocation—Process of Healing when Reduction is immediately accomplished—Alteration of Structure in cases of Old Unreduced Luxation—Importance of these Changes in regard to Practice—General Rule as to the Period and Conditions under which Reductions may be attempted in Old Luxations.

A FRACTURE generally unites in from five to six weeks. The consolidation of the bone is then pretty perfect, though the deep-seated part of the fracture is never completely consolidated till about seven weeks after the injury. Up to that time the union of the deeper part of the bone is not complete; it is still soft, and would yield readily if any weight or pressure was put on the limb. There is most danger of this yielding in fractures of the lower extremity, and hence starch bandage or other retentive apparatus should be applied after the removal of the splints. In fracture of the femur I never remove the long splint in less than seven weeks, nor allow the patient to use the limb for some time after. I have seen cases in which gradual yielding of the bone took place, and deformity occurred, from bearing weight on the limb, and this especially occurs in the young, where the bones as well as the uniting medium are still soft. In the forearm we often remove the splints at the end of three or four weeks, so as to prevent any stiffness in the articulations in the neighbourhood. We require to allow a certain amount of passive movement to prevent thickening, or adhesions of the tendons to their sheaths, but the patient must still be careful not to use the limb

freely ; only gradual passive movement of the hand and wrist should be allowed. We are obliged to choose between two evils, and therefore choose the less.

On examining a fracture after eight or ten days, we may find it apparently solid, but about fourteen days after the injury we find it less so. The cause of this is that the swelling of the surrounding parts has by this time disappeared. In almost all cases we find consolidation commencing about the end of the third week, the plastic lymph which has been thrown out becoming ossified.

Sometimes the union fails. NON-UNION of fracture, or the occurrence of ununited fracture, depends on a variety of circumstances. In the first place, it may depend on improper treatment. The surgeon not having been quite sure at first where the fracture was, may meddle with it from time to time, and then the chances are very much against the fracture uniting. Constant movements of the limb by the patient are also a very frequent cause of the non-union of fracture. These belong to the class termed unavoidable ; but although unavoidable on the part of the surgeon they are not unavoidable on the part of the patient, therefore the term is an improper one. The limb should be well set at first, and kept in a position by proper retentive apparatus, and not interfered with much afterwards. It is not powerful movements of the limb which cause non-union. The patients seldom do much harm in the first fortnight when there is still some pain, but after that there is a strong inclination to move the limb slightly. In the upper extremity patients have then a great tendency to use the fingers, and to prevent this we generally use splints for two or three weeks, which pass beyond the fingers both in front and behind. In fracture of the upper arm we are sometimes obliged to put on splints over the forearm to prevent the wrist and fingers being moved, especially if it be a fracture of the humerus close to the elbow, where movement of the wrist would keep the lower end of the humerus constantly in motion. Absolute rest of the fractured bone is essential to union, and for the purpose of en-

forcing this we apply retentive apparatus, which secures not merely the broken bone, but also fixes the neighbouring articulations, and in fracture of the arm the fingers must also be kept fixed, especially in restless patients, as in children. Independently of these movements, there are other causes which may induce non-union. Even in a simple fracture a portion of muscular texture may be nipped up between the broken ends of the bone—in oblique fractures this is not uncommon—and if this portion of muscular texture be not removed from between the ends of the bone, union is not likely to occur. According to those who believe in the blood-clot forming the provisional callus, this piece of torn muscle ought to be of great advantage in the consolidation of the bone, but the fact is that it really prevents union. In comminuted fracture, where there is a large portion of bone removed from its periosteum, and where there is a deficiency of structure, we can easily understand how the ends of the bone, instead of approaching each other, may become rounded off, and then osseous union will not take place. Again, where suppuration and necrosis occur, the loss of substance and the exhaustion of the patient may lead to non-union; but this is a very rare cause of it, for where the bone has necrosed new bone is thrown out to take the place of the portion which has been removed. There are also other local causes of non-union, such as the destruction of the vitality of the textures around, as when the fracture has been caused by very great force.

Non-union may also occur from impaired vitality of the part, as where the bone is broken in two parts with a portion between them, thus forming a comminuted fracture. In such cases, it very frequently happens that the bone unites at one part, but not at the other; and if the foramen for the nutrient artery of the bone be implicated in the injury, there is less chance of union in the deep-seated part of the fracture.

The general constitutional causes of non-union of fracture may be stated as being debilitating causes of any kind, such as long-continued discharges, where the health is exhausted,

Plate XV

FRACTURE.

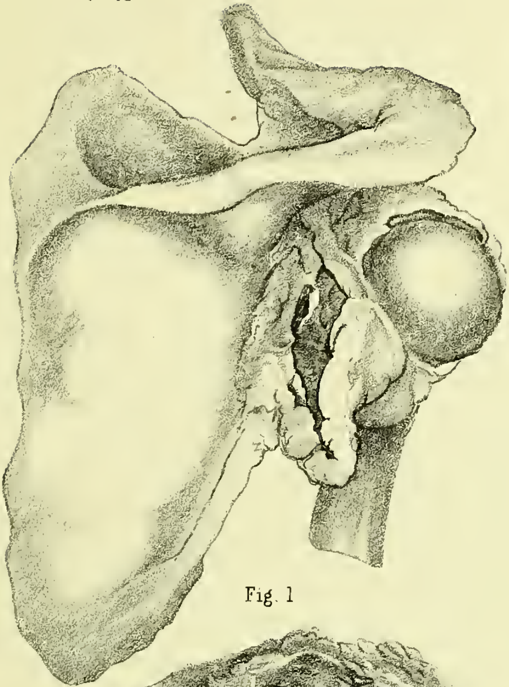

Fig. 1

Fig. 2

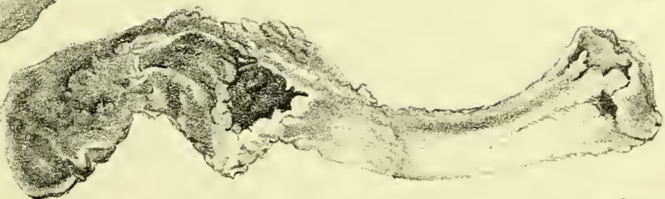

Fig. 3

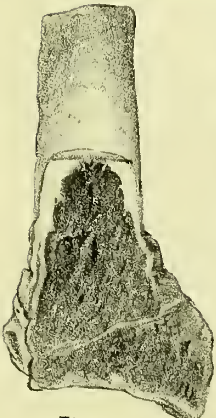

Fig. 4

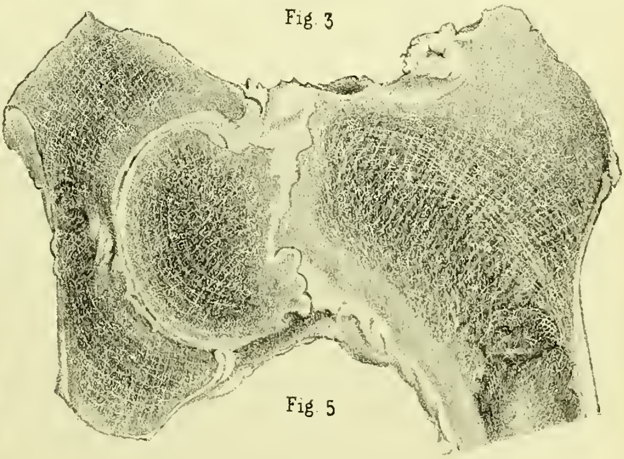

Fig. 5

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and the reparative powers are injured. In syphilis, from the cachexy existing in certain tertiary forms of the disease, this want of reparative power may cause non-union. Scurvy also, may prevent union, and may even cause the union which has taken place to give way; this has been mentioned before when speaking of the scorbutic ulcer. The previous habits of the patient, or excessive natural discharges, as in cases of menorrhagia, often impair or frustrate the uniting process. Another general cause of non-union is pregnancy, when a larger amount of blood than usual is directed to one organ for a time; the reparative power seems to go on in the other parts less perfectly; still I cannot say that I ever saw, in my own experience, a case of non-union of fracture occurring in a pregnant woman, though such cases have sometimes been met with.

When union does not occur, we may have two or three different conditions of the broken bone. We have sometimes simply non-union, as when a portion of necrosed bone prevents it, but where, after removing this dead portion of bone, union takes place. In certain cases whilst osseous union does not take place, there may be a certain amount of fibrous texture uniting the ends of the bone, and so forming one kind of false joint. In other cases the ends of the bone are atrophied, rounded off, covered with glistening fibrous tissue, and connected with each other by a fibrous capsule, continuous with the periosteum of the broken bone, thus allowing free movement, and forming the most perfect example of false joint.

Various methods have been adopted to bring about union in these cases. The constitutional treatment is important, and here one condition in particular should be attended to. In patients with fracture of the lower extremity, we may find that at the end of four weeks or so there is little or no union, even though the patient has had full diet without stimulants. If the patient has been in the habit of taking stimulants the fracture is not likely to unite so long as he is deprived of them, and even when he has not been much accustomed to them it is often necessary to give stimulants to pro-

duce union of the fracture. If we take down a fracture at the end of five weeks, and find it not united, we should then carefully reapply the retentive apparatus, fix the parts in every direction, keep up moderate extension, and then retain the limb unmoved for some time. Even here I do not like the use of the starch bandage, for it is very apt to get loose, instead of fitting firmly to the limb; and hence I prefer an ordinary bandage, the condition of which can be easily seen. By carefully reapplying the retentive apparatus, and paying proper attention to diet, etc., such a fracture will often be made to unite, but not always, and then what is to be done? The plan of treatment which I have found very useful is a method proposed by the late Professor Miller—namely to tear up, subcutaneously, with a long needle the fibrous texture on the ends of the bone, and so expose again the osseous structure. The periosteum should also be torn up for some little distance beyond the fracture, so as to excite some irritation. The retentive apparatus is then reapplied very carefully, and the limb kept in position for several weeks, and under this treatment I have found some ununited fractures unite perfectly. This method of subcutaneous incision and tearing up of the fibrous texture ought, I think, always to be tried before having recourse to any of the more severe methods of treatment; but to be of any use it must be done thoroughly—we must tear up the fibrous texture completely, and feel that the needle is between the ends of the bone. We should also tear up the periosteum for some little distance, so as to excite action in it and cause the deposition of earthy matter from its interior, and so give a better chance of consolidation.

When this method fails to bring about union, we must then adopt more severe measures. The most general method used to be the introduction of setons. An incision was made down upon the ends of the bone, and a seton passed between them, and brought out on the opposite side of the limb, taking care, of course, to avoid the great vessels and nerves of the limb. The object of this was to excite action. The seton was left in, till some inflammation and suppuration came on, and was then re-

moved. It ought to be left in only till excited action occurs, for otherwise there is danger of acute necrosis of the shaft coming on, and in some cases this simple operation has led to amputation. On the withdrawal of the seton, the retentive apparatus should be again applied, and the parts kept perfectly fixed for some time. This simple-looking operation of passing a seton between the ends of the broken bone was often attended by very serious consequences, such as necrosis of the bone, suppuration and irritative fever, and even the death of the patient, and very generally it was found that union had not taken place, and that the parts were still movable.

The next plan is that of resection of the bone. It is generally found that in the worst cases of non-union the ends of the bone are atrophied, and only approach one another without having any tendency to unite. In the treatment by resection, an incision is made over the fracture, the ends of the bone laid bare, and an inch or so is sawn off each end. The ends of the bone are then replaced, and the limb put up again in the retentive apparatus. This is practically turning a simple fracture into a compound one ; and in many cases, necrosis, suppuration, irritative fever, and pyæmia come on, and often amputation of the limb has to be performed afterwards. A modification of this plan, however, is the one which I still have recourse to as a last resort. In 1854* I published a case in which I had carried out the treatment on a principle of my own. It was a case of non-union after fracture of the humerus in a young man. In this case I removed the ends of the bone, which were atrophied and rounded off, but not with the saw. I merely snipped off the rounded ends of the bone with the bone-pliers, so as to remove only a very small portion of bone, and this was done without lifting out the bone from the soft textures. In this case the union of the fracture took place in about six weeks, and I have since employed this method successfully in several cases, though not in all in which I have tried it. The principle is one in which I have great confidence. The less disturbance of the soft parts

* See Clinical Cases at end of this section.

and of the broken ends of the bone the better, and the less bone removed the better. Besides, the resection with the bone-pliers resembles a fracture more closely than that made with the saw.

All cases of fracture, however, are not suitable for resection, and then another method of treatment may be adopted, but the plan is only applicable to certain forms of fracture—namely, oblique fractures. This plan consists of the introduction of pegs into the fracture so as to keep the ends and surfaces of the bone fixed together, and also to excite action in the bone. An incision is made over the fracture, and a hole is bored through the ends of the bone which are overlapping each other without being united ; a steel or an ivory peg is then introduced into the hole, and the ends of the bone are thus brought firmly into contact. This plan was first adopted by Dieffenbach, who, noticing that the presence of a piece of necrosed bone caused a great deal of action in the part, thought that by making the ivory peg represent the necrosed portion of bone, the same amount of action would be excited, and the peg could be removed afterwards like the necrosed bone. The principle and the reasoning are good, and in certain cases of oblique fracture this plan has met with success, but still it has not been so successful as might have been wished. The pegs sometimes give rise to irritation and acute necrosis of the bone without causing union, still it is a method which I would have recourse to after all other means had failed to cause union, especially in oblique fracture of the tibia, where the bone is so superficial. At first sight the plan looks absurdly mechanical, but the principle of it is good—namely, to excite action in the bone, and not merely to keep the parts together mechanically.

These are the principal methods of treating ununited fracture, but the slighter operations should be tried first, especially the subcutaneous method of incision, and that failing, the removal of merely the ends of the bone with the bone-pliers.

We must attend carefully to constitutional treatment, for without that all the other means will fail.

I now proceed to notice briefly the changes which take place

consequent on dislocation as contrasted with those after fracture. When a bone is dislocated a considerable amount of injury is caused to the connecting ligamentous textures. In the case of the capsular joints, such as those of the shoulder and hip, we have the proper capsule of the articulation torn through at its weakest point, generally towards the lower or inner part of the capsule, and the muscular textures are also injured. At one time it was supposed that dislocation might take place without this occurring. It was thought that simply from the elongation of the elastic fibres the head of the bone might escape from its articulating surface without actual rupture of the ligamentous texture; but no practical surgeon, so far as I know, ever believed in it, it was merely a theory. We find that in all cases the ligaments are ruptured, and sometimes even the capsular muscles torn from their insertion, by the degree of force causing the injury. If the head of the bone be reduced at once, the capsule and the other soft textures heal by the process of adhesion, though the cicatrix will not be so strong as the natural texture. In the hinge-like joints the lateral ligaments sometimes give way, but seldom so completely as the capsular ligaments. In the elbow-joint, for example, it is simply the anterior and posterior ligaments which give way and allow of the displacement.

When the dislocation is reduced, as a general rule the capsule heals, and the use of the limb is perfectly restored. If, however, a dislocation has been left long unreduced, the joint remains stiff for some time, but afterwards the mobility increases. The movements, indeed, are not the natural movements of the joint, but they allow the patient to move the limb to a considerable extent, and it becomes tolerably useful. If such a patient be brought to a surgeon, reduction should hardly be attempted if the joint be very movable, for the chances are against reduction being accomplished. The fact is, that a new articulation is being formed, and this accounts for the movements being so free. The surfaces of the bone always become more or less altered. The glenoid cavity, for example, becomes some-

times reduced to a semilunar form (Plate xv. Fig. 2), part of it and also of the head of the humerus being marked by a porcellaneous deposit. A new joint has been formed, so that it would be of no use to reduce such a dislocation, as the glenoid cavity has become altered in shape. So also when the head of the radius has been dislocated backwards, the joint becomes completely altered in form, and the head of the radius is also altered; and here too it would be useless to attempt reduction, for the natural movements of the joint could not be restored.

Whenever we have a dislocation long unreduced, where there is considerable motion of the joint reduction is contra-indicated. In ordinary cases reduction may be attempted in the dislocations of the hip or shoulder joints, even after some months, while in joints like the elbow reduction after a few weeks is excessively difficult, often impossible.

The *treatment* of luxation is termed reduction, and consists in restoring the dislocated bones to their natural position. This process is effected by forces applied generally in the form of extension and counter-extension, and kept up until the object is attained. Counter-extension consists in fixing the articular surface nearest the trunk, so as to prevent it yielding to the extending force employed to act on the dislocated bone. It is usually managed by means of a sheet or laque, or the hands of an assistant, or by the surgeon placing his knee or foot so as to fix the part, whilst he makes extension with his hands, or by means of pulleys, according to the degree of force required. Extension is usually made by drawing down the dislocated bone in the axis in which it has been displaced, whilst at the same time the foot or knee which is used to fix the articular surface from which it has been dislocated is also made to form a fulcrum, over which the shaft of the luxated bone is made to act as a lever to raise its articular extremity from its abnormal position, and bring it within the action of forces which tend to replace it. In other cases, instead of using extension, the reduction is accomplished by fixing the trunk, and then moving the luxated bone in such a manner as to tilt its articular extremity from the abnormal posi-

tion, as in the instance of luxation of the femur into the obturator foramen. The amount of force required will vary according to the nature of the dislocation and the length of time it has remained unreduced.

Formerly preparatory treatment required to be used to overcome opposing muscular power. The warm bath, venesection, antimony, and tobacco enemata, were used for this purpose. The use of chloroform has now completely superseded these debilitating preparations for reduction, as under its effects all muscular resistance is got rid of, and hence reduction of dislocations, except in old unreduced luxations, is now a comparatively easy procedure. Various mechanical contrivances have been used to afford increased power in reducing old dislocations. The simplest and most efficient of these are the pulleys, or block and tackle. A làque of worsted is fastened round the lower part of the dislocated limb in the form of the "clove-hitch," and the hook of the pulleys is fastened into the free ends of the laque. Before applying the worsted laque, a wetted bandage should be rolled round the limb at the part where it is to be applied, so as to prevent the traction causing excoriation of the skin, and after the laque is put on above this the remainder of the roller is used so as to fasten the laque, still further to prevent all chance of its slipping. Extension is then made by the pulleys very gradually, whilst counter-extension is kept up by means of a sheet or special apparatus fastened to a ring-bolt in the floor or wall, or to some fixed piece of furniture in the room.

The methods of carrying out these general principles will, however, be better inculcated when treating of the special dislocations.

Recently a procedure termed reduction by manipulation has been recommended by Dr. Reed of Rochester, U.S., and has proved successful in several cases. It consists in executing certain movements of the dislocated limb by the hand alone, and has been principally used in dislocations of the hip, and will be described when I speak of these, but it is also applicable to other joints.

Compound Dislocations are very dangerous accidents, more so indeed than even compound fractures, with which they have many features in common. In some favourable cases, in young persons, by immediate reduction, closing the wound accurately, and applying carbolic oil covered with gutta percha, or varnishing over the wound with collodion, or similar medium, so as to exclude all external sources of irritation, and by adopting the ice treatment recommended for wounds of joints, together with careful after-treatment, we may save a useful limb. In most cases, however, either primary resection of the joint, or amputation, if the surrounding textures be much injured, requires to be performed. In patients above middle age I believe amputation to be the safest plan ; but the surgeon must judge of the conditions in every individual case. I would refer you to what I have already said on the subject of wounds of joints, and lacerated, contused, and gunshot wounds, as bearing on this subject, and as enabling you to decide on operative or other measures in the treatment of compound luxations.

LECTURE XLIX.

Fractures of the Clavicle—Symptoms and Causes of Displacement—Treatment—Dislocations of Clavicle—At Sternal Extremity—Secondary Dislocation from Disease of Spine, and Operative Measures required for its relief—At Acromial end—Appearances somewhat resembling Dislocation at Shoulder Joint—Prognosis and Treatment—Fractures of Scapula—Fracture of Neck, simulating Dislocation into Axilla—Treatment.

THE CLAVICLE may be broken at different parts, according to the direction of the force which causes the injury, but the point of all others where it usually gives way is just a little to one side or other of the middle of the bone. When fracture occurs at this part, the displacement is very marked. The outer end of the sternal portion of the bone projects, and appears to be drawn upwards. The shoulder falls down, and is drawn forwards and inwards towards the chest, so that the axillary space is diminished in size. The patient generally keeps the arm semi-flexed, and supported by the opposite hand. The slightest movement of the shoulder causes intense pain. The patient can usually make out the diagnosis of the injury himself. The symptoms, then, are—projection of the outer end of the sternal portion of the bone, depression of the acromial end, falling-down of the arm, and pain on movement of the parts. The causes of these symptoms are first and principally the weight of the arm bearing on the scapula and the acromial end of the clavicle, and so dragging down the outer fragment. The internal, or riding end of the bone, is little, if at all, displaced; it remains equipoised between the clavicular attachment of the sterno-mastoid above, and the clavicular fibres of the pectoralis major and the rhomboid ligament beneath, so that the muscular forces are nearly balanced. The muscles attached to the scapula and humerus—the pectoralis major and minor, the latissimus dorsi, teres major and subclavius—tend to drag the

arm and shoulder downwards and inwards towards the chest. The appearances, therefore, of the narrowing of the chest, and the riding of the bone, are readily accounted for—the principal displacing cause being the weight of the limb. When we lay the patient flat on his back in bed, and raise the elbow, the fractured bone is easily returned to its normal place; and if the patient were kept always in this position, no other treatment would be necessary than to keep the arm fixed across the chest.

The clavicle may also be broken very near its sternal end, sometimes quite close to the articular surface, so that the injury may resemble very closely a dislocation of the clavicle from the sternum. In this fracture the displacement is downwards and forwards. The shaft, or outer part of the bone, has its inner end drawn inwards upon the sternum by the subclavius and pectoral muscles acting on the clavicle and arm. The broken end of the bone can be distinctly felt moving on the sternum, as if it were dislocated, but the fractured surface and the crepitus on reduction distinguish this injury from a dislocation. The movement of the broken end of the shaft in front of the sternum causes considerable pain to the patient. Any movement of the arm also causes pain. The fracture, therefore, is easily recognised, and the treatment very simple, all that is necessary being to reduce the fracture and keep the parts at rest in the proper position for two or three weeks until union has taken place. Fracture at this site is, however, much rarer than in the middle third of the bone.

The clavicle is also sometimes fractured between the two portions of the coraco-clavicular ligament—in the interval lying between the conoid and trapezoid. The injury is generally caused either by a direct blow on the bone at or near the point of the shoulder, or by a counter-stroke received in falling upon the shoulder. This accident is attended with very little displacement, either primary or secondary. When the fracture occurs exactly between the two portions of the ligament, there is little if any displacement, for the ligamentous textures keep the two ends of the bone so far fixed to the scapula and to each other. But it is very seldom that we find the fracture corre-

sponding exactly to that interval. The more general site is a little external to the conoid and trapezoid ligaments, and therefore beyond the reach of their direct counteracting influence, so that the resulting displacement is often considerable. There is no difference in the level of the bone, but the fractured ends are displaced in the antero-posterior direction. As the displacement does not occur immediately, this makes the fracture more difficult of diagnosis. There is often no alteration visible at the time of the accident, but great deformity may arise subsequently, if the fracture be not recognised and treated at first. You will be best enabled to do this by running the finger along the line of the bone, and placing it deeply over the seat of pain. Then, by fixing and rotating the scapula and humerus, you will generally be able to make out a deep-seated crepitus. Fracture at this site is by no means uncommon. It is met with less frequently than fracture of the middle portion, but oftener than at the sternal extremity. As I have already stated, it occurs generally beyond the outer portion of the coraco-clavicular ligaments, and leaves them, therefore, undisturbed in their position. The active displacing agents will be evident to you. These are partly muscular, and partly due to the weight of the arm. The shoulder is drawn inwards, and becomes narrower. It does not droop much. The outer portion of the bone becomes gradually drawn round, until it lies in an antero-posterior direction to the shaft. This arises from the pectoralis minor, assisted by the rhomboidei muscles rotating the scapula, so as to depress and draw forwards the point of the shoulder, together with the outer fragment of the bone. The rhomboideus major and minor and other muscles depress and rotate forwards the anterior angle of the bone; whilst the trapezius, which would naturally oppose that action, acts only on one part of the scapula, and tends rather to carry it backwards, so that the acromial fragment of the clavicle is placed at a right angle with its shaft. This causes great deformity and comparative uselessness of the arm. If we put up the fracture at once, keeping the shoulder back, and confining the movements of the scapula, it will unite with-

out much deformity; but if we neglect this, the usefulness of the arm will be much impaired.

Fractures of the clavicle generally mend by osseous union; and, if the parts be maintained in accurate apposition, and at rest, the process of repair is completed in a very short time. After union, the site of fracture is often marked by a considerable thickening of the bone, and often by a decided deformity. This depends chiefly on the direction in which the solution of continuity occurs. Transverse fractures unite most readily; and the greater the degree of obliquity, the greater is the difficulty of maintaining apposition, and the greater the risk of resulting deformity.

The indications of *Treatment* are obvious. They consist in the restoration of the displaced parts to their normal position, and the retention of them there. This is effected by carrying the shoulder upwards, outwards, and backwards. The apparatus employed for this purpose requires to be varied according to circumstances. For fractures at the inner or middle thirds of the bone the axillary pad will generally be found an efficient means to employ; while for those which occur in the outer third, either within or external to the ligaments, it will generally be found necessary to brace back the shoulders by means of a figure of eight bandage or two handkerchiefs, or the special apparatus (Plate xvi. Fig. 2), which is in reality by far the most efficient method. In connection with the axillary pad, three handkerchiefs are used. One is employed for the purpose of securing the pad. It is made to cross over the opposite shoulder, and then tied under the corresponding axilla. The second handkerchief is used for a sling, and the third serves to fix the arm to the side of the body. The arm should be flexed to an acute angle, so that the fingers almost touch the opposite shoulder (Plate xvi. Fig. 1). Various ingenious mechanical contrivances are in use, but they are designed on the same principles, and are better or worse modes of effecting the same objects.

Plate XVI

FRACTURE & DISLOCATION

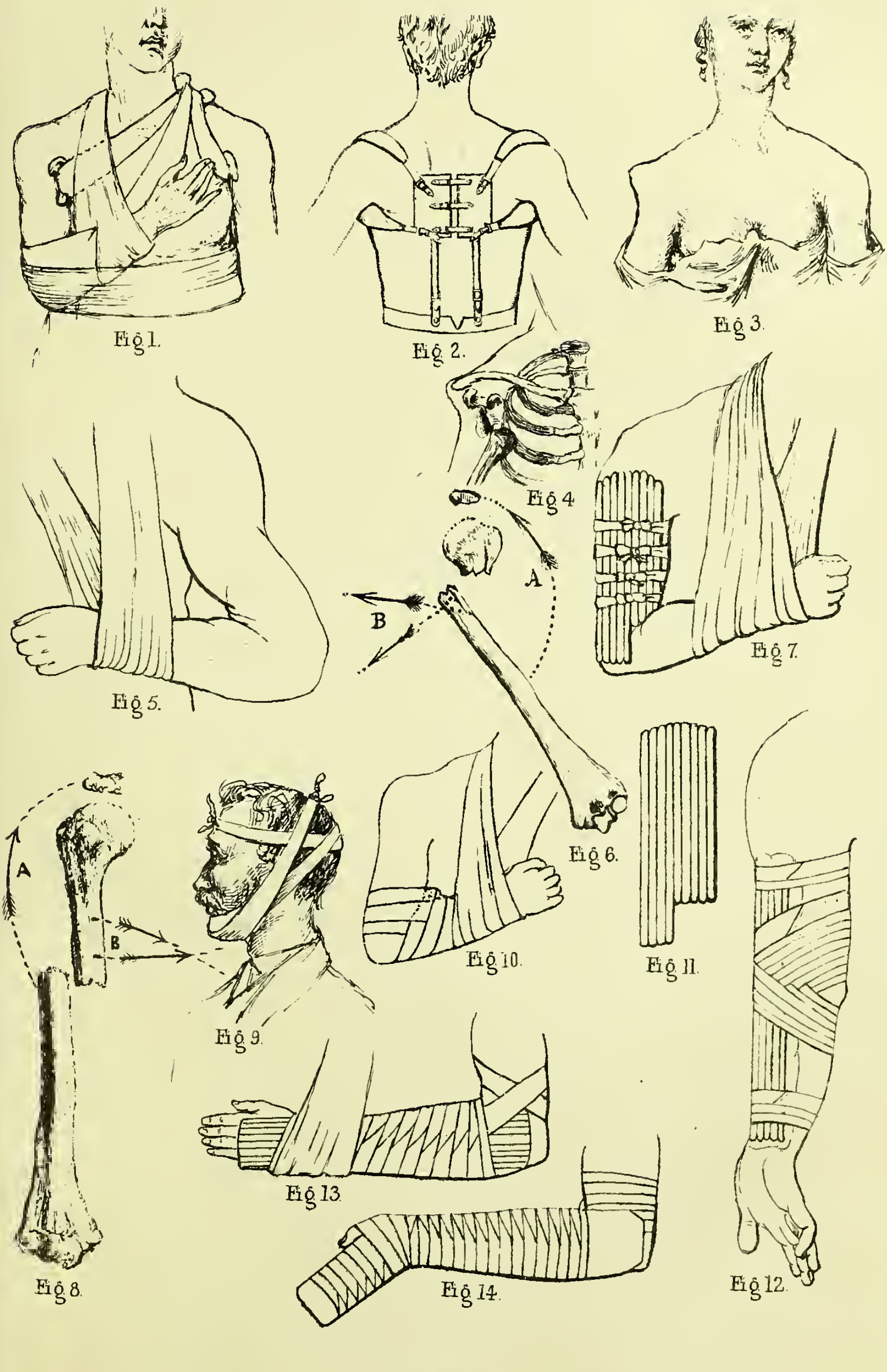


Fig 1. Fig 2. Fig 3. Fig 4. Fig 5. Fig 6. Fig 7. Fig 8. Fig 9. Fig 10. Fig 11. Fig 12. Fig 13. Fig 14.

The Dislocations of the Clavicle are two in number—namely those of the acromial and sternal ends.

Dislocation of the sternal end occurs less frequently than that of the acromial end. It is caused by the patient falling on the point of the shoulder. The sternal end of the bone is thereby thrust forwards forcibly, so as to rupture the anterior part of the capsular ligament of the joint, and project forwards upon the sternum, where it forms a large and very marked swelling. The symptoms of this dislocation are so marked that the diagnosis is very easy. The bone is reduced by drawing back the shoulders. The elbow is then brought to the side, and a broad figure-of-eight bandage, with a pad over the dislocated end of the clavicle, applied.

Dislocation of the sternal end may also take place backwards and upwards behind the sternum towards the neck, but this rarely happens. It then presses upon the œsophagus and the great vessels at the root of the neck, and may give rise to serious consequences. This condition may also arise in consequence of disease of the spine, and then it is a sort of secondary dislocation. In such cases it has been found sometimes necessary to cut down upon the clavicle and remove the sternal end of the bone, so as to get rid of the pressure caused by it. This is exceedingly rare, and is hardly a dislocation proper.

Dislocation of the acromial end of the clavicle is not very uncommon. There is comparatively a very small surface of the broad end of the clavicle articulated with the acromion, and if a person falls on the point of the shoulder, the end of the clavicle may be projected from the acromion, and dislocated. The ligaments which keep it in position give way, and it remains merely attached to the coraco-clavicular ligaments, which do not generally yield. Hence the arm does not fall very much at first, though it may do so afterwards, and then the acromial end of the clavicle projects, giving rise to appearances somewhat like those seen in dislocation of the humerus. On looking at them from the front, the two cases appear very much alike, as they both present a marked elevation at the point of the shoulder,

and a depression underneath. Looked at sideways, a marked difference will be observed, inasmuch as the end of the clavicle will in this injury alone be seen instead of the broad arch formed by the acromion and clavicle in dislocation of the shoulder, Moreover, the edge of the trapezius, tending to draw back the clavicle, is seen to stand out in bold relief. Without these precautions you may make a mistaken diagnosis. All doubt will be dispelled when you begin to manipulate the parts.

This dislocation requires great care in the treatment. Sir Astley Cooper affirmed that it never healed. He said that the articulating surfaces were so small, and the ligamentous textures united so imperfectly, that it was impossible to keep the parts in accurate contact. I have found in some cases that, though the dislocation was easily enough reduced at first, it never healed completely ; but in the majority of my cases the dislocation has done well enough. The parts become firmly united, and no deformity is left, the arm remaining as useful as before. The result depends a good deal on the care taken by the patient himself. The *Treatment* of this dislocation is very much the same as that recommended in fracture of the clavicle, and almost the same apparatus is required. We must, however, not only brace back the shoulders, but we must have a pad pressing upon the acromial end of the clavicle, so as to keep it for at least six weeks in close apposition to the bone with which it is articulated, in order that the fibrous textures may unite thoroughly. Here is a cast taken from the shoulder of an old man, a patient of mine, who suffered from this injury, and who, from his age and habits (he was not an abstainer), gave little hope of recovery, yet with care and extra precautions he was entirely restored.

The Scapula may be broken almost at any point. It is generally broken obliquely through its spine. The fractures of the body of the scapula are generally caused by great and direct violence, and are attended with much swelling and pain.

Deep-seated crepitus may be discovered on moving the arm, or by grasping the coracoid process with one hand, and moving the body of the scapula with the other. The *treatment* consists

in confining the movements of the bone by a bandage, placing a pad in the axilla, and keeping the arm close to the side. In fracture of the acromion there is generally drooping and rounding of the shoulder, with a want of power in raising the arm ; it is generally merely the point of the acromion that is broken off. The treatment consists in placing a pad in the axilla, and keeping the arm fixed to the side—the same apparatus as is used in most fractures about the shoulder-joint.

There is a fracture of the scapula which occurs, though very rarely, and which is difficult to diagnose from dislocation at the shoulder. This is fracture of the neck of the scapula, or fracture through the glenoid cavity detaching almost all that part of the bone. This fracture was first described by Sir Astley Cooper. In it the shoulder presents a square appearance, and a cavity is seen below the acromial arch, just as in dislocation of the shoulder. The elbow projects from the side, and when we raise the arm and draw it out the dislocation disappears. The existence of this fracture is denied by some, and one of Sir A. Cooper's supposed cases was proved after death not to have been fracture of the scapula at all, but an oblique fracture through the head of the humerus. The fracture, however, really does occur, though it is very rare; for I had a case in hospital where the body was examined after death, and the scapula was found to be broken through the neck of the glenoid cavity (Plate xv., Fig. 1).*

The *treatment* is the same as in fracture of the neck of the humerus or of the clavicle: place a pad in the axilla, and fix the scapula by a broad handkerchief or bandage, keeping the arm slung and the elbow bound to the side. The fracture unites readily enough, and leaves a useful arm.

* See Clinical cases at end of Section.

LECTURE L.

Fracture of Neck of Humerus—Diastasis—Inter-articular Fracture in Adults—Displacing causes in Fracture of Surgical Neck—Diagnosis between these Injuries and Dislocations—Treatment—Dislocation of Humerus at Shoulder-joint—Diagnostic Symptoms—Treatment—Different modes of Reduction—Fracture of Surgical Neck of Humerus accompanying Dislocation—Mode in which the accident occurs—Treatment.

Fracture of the Neck of the Humerus.—This term is usually applied to fracture of the surgical neck of the humerus. Fracture through the anatomical neck is comparatively rare, and generally occurs in the form of diastasis in young subjects before the epiphyses are fairly connected with the shaft of the bone. An inter-articular fracture does, however, occasionally occur in adults. In fracture of the surgical neck we have the humerus shortened, the elbow slightly tilted from the side, and a depression formed a little above the insertion of the deltoid muscle. The shoulder is rounded, and there is often some degree of swelling, which adds to this appearance. If we pass the hand from the acromion process downwards, we feel the head of the humerus in its place, and then lower down we feel the depression above the insertion of the deltoid. The head of the bone is kept very nearly in position by the capsular muscles. The shaft of the bone is very much displaced, its axis being altered by the tilting outwards of the lower portion. The upper part of the broken shaft is drawn in towards the axilla and chest by the action of the muscles attached to the bicipital groove—namely, the pectoralis major, the latissimus dorsi, and the teres major. The deltoid still further assists this displacement by drawing the shaft upwards. The fracture is therefore attended with shortening, great distortion, and loss of power in moving the arm.

(Plate xvi. Figs. 5 & 6). The surgeon can, however, move the limb, though this causes pain to the patient. When the arm is forcibly extended we feel crepitus. We may rotate the shaft of the humerus without producing any, but if we rotate the arm after extending it, so as to bring the broken surfaces of the bone in contact, crepitus is produced. Fracture of the surgical neck is almost always caused by direct violence, such as falls or blows on the shoulder.

As we have already stated, fracture of the humerus between the tuberosities and the head of the bone, that is through the anatomical neck, occurs also, though not so frequently as the former fracture, and chiefly in young children, where the cartilaginous head of the bone is but loosely connected with the tuberosities. An unusual force applied to the elbow or shoulder may produce it. There is much difficulty in diagnosing between this diastasis and dislocation. When the comparatively small portion forming the proper head of the bone is left in relation to the glenoid cavity, the arch of the acromion projects, the tuberosities fall into the axilla and are drawn towards the chest, the shoulder is square and not rounded, so that all the appearances of dislocation may be produced. Then the symptom of crepitus is wanting in this fracture on account of the semi-cartilaginous state of the bones in the young subject. Still we can, by a little extension, and by putting the arm in position, bring the tuberosities up into contact with the acromion process, and then the roundness of the shoulder is restored, and the axis of the shaft of the humerus is restored also. These results, however, are only temporary, for whenever we take away the support the bone falls out of position, showing that the case is not one of dislocation but of fracture or separation.

Fracture of the anatomical neck also occurs in adults, perhaps more frequently than is supposed, but generally it is partly extra-capsular as well as intra-capsular. One part of the fracture, therefore, corresponds to the anatomical neck, the other occurs obliquely through the tuberosities. This is almost invariably the case in adults.

The treatment is very simple if we once recognise the lesion, and it ought to be easily recognised. The arm should be extended, and the ends of the bone brought into contact, and kept in that position. The elbow should be brought to the side, and a pad of wadding placed in the axilla. This acts as a fulcrum, —the humerus being the lever—and effectually prevents the broken end of the bone from being drawn in again towards the chest. The essential parts of the retentive apparatus, therefore are, a pad in the axilla, a sling for the arm, and a roller to secure the elbow to the side.

The position of the arm should be different from what it is when placed for the treatment of fracture of the clavicle, in which case the elbow is bent at an acute angle, and thrown across the chest obliquely, with the fingers resting on the opposite shoulder. In treating this fracture, the arm should be kept parallel to the side, with the elbow bent at a right angle and supported by a sling. In fractures of the shaft of the humerus the sling is so placed on the forearm, as to leave the elbow free. Thus the weight of the lower part of the limb is made to act as an extending power. Some surgeons hold that this should also be done in fracture of the surgical neck ; but I do not consider it good treatment, for the ends of the bone are not likely to be kept in contact unless the elbow is supported. If this be done with the pad in the axilla, there is no fear of the parts overlapping each other ; but if support be not given to the elbow, there is a very great risk of imperfect union. In some cases splints are applied ; now a splint is of no use as regards accuracy in the coaptation of the fracture, for the internal splint cannot be placed so high as the point where the bone is broken. We cannot get a splint so far up into the axilla, and the outer splint is of no use without the inner one. Splints should only be put on in children or very restless patients, where we wish to prevent movement of the hand, wrist, and elbow, so as to obtain perfect rest for the broken bone. But for securing coaptation in this fracture splints are useless. The treatment of fracture of the anatomical neck of the humerus is exactly the same as that of fracture of the

surgical neck; and this injury generally unites readily without deformity or loss of power in the arm.

Dislocations of the Shoulder may, for all practical purposes, be described as three in number:—

1. Dislocation downwards into the axilla.
2. Dislocation forwards.
3. Dislocation backwards.

The second of these is subdivided by many into two stages, but this subdivision is unnecessary. The third form is exceedingly rare; I have never seen a case of it.

Certain symptoms are common to them all. One of these is a peculiar well-marked flattening of the shoulder. In fracture of the neck of the scapula, and also in diastasis of the head of the humerus from the tuberosities and shaft, we meet with the same appearances, causing these injuries to resemble dislocation. In them the shoulder undergoes an equal alteration in its contour, and there is a similar cavity or depression formed under the acromion process. The squareness of the shoulder is caused by the head of the humerus being forced out of the glenoid cavity, and so leaving the arch of the acromion prominent.

In dislocation of the head of the humerus downwards into the axilla, the arch formed by the acromion process and the clavicle is left projecting, and there is a large cavity corresponding to the normal position of the head and tuberosities of the bone. This produces the squareness of the shoulder, together with lengthening of the limb, a slight tilting-out of the arm, and considerable pain and swelling, owing to pressure by the head of the bone on the axillary plexus of nerves. In the natural position of parts, if we trace with the finger forwards and downwards from the acromion process, we come directly upon the tuberosities of the humerus; but, in the dislocation, we come at once upon a space from which the head of the bone has been removed. It may be observed here, however, that if we examine at the back of the arm, especially in a thin person, we can feel a depression even though there be no dislocation. In front the coracoid process can

always be felt on the inner side of the head of the humerus in the normal position of parts, and if we feel this we may be sure that the head of the bone is in its right place. Thus the position of the acromion and coracoid processes of the scapula, with reference to the head of the humerus, forms the best diagnostic guide in assuring us of the presence or absence of a dislocation. If the head of the bone be felt away from the coracoid and acromion processes, resting on the neck of the scapula, and the axis of the humerus be slightly altered, being more oblique than it naturally is ; and if the head of the bone can be made to move slightly, so that we can feel it in the axilla, though we cannot rotate it freely ; we may conclude that we have to do with such a dislocation as we have described.

In dislocation of the head of the humerus forwards, the symptoms may vary somewhat, according to the degree of the injury and the nature of the force which caused it. Dislocations forwards are almost all caused by the patient falling with the hand outstretched. This dislocation is generally sub-coracoid—that is, the head of the bone lies under and to the inner side of the coracoid process. Sometimes it may lie much more upwards and forwards, nearer to the clavicle. This injury is marked by shortening of the arm and greater abduction of the elbow. The head of the bone can be traced to the inner side of the coracoid process, and quite away from the acromion process and the glenoid cavity. It is attended with the same squareness of the shoulder as are the other dislocations, and the same, or even a greater alteration, in the direction of the limb. The latissimus dorsi and teres major muscles draw the bone in towards the chest, and the deltoid and pectoralis major draw the head and tuberosities upwards towards the cavicle, thus producing a considerable degree of shortening of the limb. In some cases there is great pain in the axilla from the increased pressure on the axillary nerves. This is not a constant symptom; the pain is often not so great as in the dislocation downwards, for the nerves sometimes seem to slip over the head of the bone and so

escape the pressure. Sometimes in this dislocation there is considerable œdema and coldness of the limb, from the interrupted circulation, both venous and arterial. In dislocation downwards there is lengthening of the limb; whilst in this dislocation the limb is shortened and the elbow is more tilted out, and the axis of the shaft more oblique.

In dislocation of the head of the humerus backwards, the head of the bone rests on the dorsum of the scapula, the elbow is tilted forwards and outwards, and there is the same squareness of the shoulder as in the two former cases. This injury should be easily diagnosed, from the head of the bone forming a projection on the dorsum of the scapula, and there would be a marked alteration in the position of the arm.

We must now attend to the method of reduction in these dislocations. In dislocation of the head of the humerus, we have a better chance of success, even some time after its occurrence, than we would have in treating a hinge-like joint for the same injury. Yet, in all cases, the sooner reduction can be effected the better. If the case be recent and uncomplicated, all that we require to do may be to fix the scapula with the knee in the axilla, and draw upon the arm, when the dislocation is reduced almost spontaneously.

The patient should be seated on a chair. The surgeon places himself beside him, separates the arm sufficiently to admit his knee into the axilla, then resting his foot on the chair, he grasps the arm just above the elbow with his right hand, and fixes the acromion with his left. He then draws down the arm over his knee, and reduces the dislocation.

As a general rule, the best method of reducing dislocations of the humerus is to place the patient in the recumbent posture, and bring him thoroughly under the influence of chloroform. The surgeon sits down beside and fronting the patient, separates the injured arm from the side, to enable him to place his heel in the axilla, so as to fix the scapula, and form a fulcrum over which he extends the dislocated bone by grasping the arm

above the elbow and pulling downwards, or downwards and outwards, as the case may require. In general the reduction is readily effected. The heel should be pressed outwards away from the chest and towards the arm, so as both to avoid injury to the ribs, and act more efficiently as a fulcrum for the arm. The forearm should be bent to relax the long head of the biceps, and also to enable the surgeon to rotate the humerus at the same time that he extends. More extending power can be obtained, if necessary, by applying a worsted laque, or large handkerchief, in the form of the clove-hitch, above the elbow, and pulling by the ends of the laque so formed. (Plate xix. Fig. 5.)

In cases where we use pulleys, a wetted bandage is placed round the limb before applying the laque, to obviate the risk of the laque slipping, and prevent excoriation of the skin.

In these methods, the knee in the one case, or the heel in the other, serves as a fulcrum over which the shaft of the humerus is used as a lever to raise its dislocated head from its abnormal position.

A third method of reduction, sometimes used, is as follows: The surgeon standing, or sitting on a chair, behind the recumbent patient, desires an assistant to fix the patient's body. He next places the sole of his foot against the upper surface of the acromion, so as to fix the scapula; then, seizing the dislocated arm by the hand and wrist, he draws it outwards, upwards, and backwards, until it is brought up almost parallel to the patient's head and neck, and, by continuing extension, the head of the humerus may slip into the glenoid cavity.

Sometimes pulleys are used for purposes of extension, while the trunk and scapula are fixed by laque to a ringbolt or some fixed point. An assistant at the same time draws the arm outwards at the dislocated part by means of a towel placed around it. This is simply a modification of the modes already described, by which a greater degree of force, gradually and evenly applied, is brought to bear on the operation

Various other methods have been advocated, and are employed, with greater or less advantage, according to circumstances ; but they are all founded on the same obvious principles, and, whichever you adopt, bear in mind that the extending force must be applied gradually, and the manipulations performed with care.

When the head of the bone has been restored to the glenoid cavity, we place a pad in the axilla, and the arm is kept fixed to the side by a sling. If the head of the bone happens to have escaped through a small opening in the ligaments, the reduction will be much more difficult than if the opening be large ; and if the ligamentous textures be tense, the difficulty will be still greater. When we once begin to attempt reduction in long-standing dislocations, we do not like to give up without effecting it, but we should remember that our efforts to do this may cause greater damage than the unreduced dislocation would. If we find, after a fair trial by pulleys and other means, that we cannot reduce the dislocation, then we should stop, especially in old people, whose arteries are liable to give way. Such an event as this would complicate the injury very much.

Another condition must be remembered in these dislocations —namely, that we may have a fracture of the surgical neck of the humerus accompanying the dislocation, though at one time this was doubted. When this accident happens, the dislocation occurs first, and afterwards the dislocated shaft of the bone is broken. I do not believe that, if the fracture should take place first, any amount of force could dislocate the head of the bone. The dislocation always takes place first, and then the bone is easily enough fractured. This injury is easy to make out when present, but the reduction is exceedingly difficult, for we have no power to act on the head of the bone, and, in fact, we depend more upon chance than upon anything else. If the head of the bone have escaped through a small opening in the ligamentous textures, it is hopeless to try and effect reduction,

but we have a much better chance if the opening be large. In such cases the limb must be kept in the retentive apparatus for five or six weeks, and must be treated just like a fracture of the neck of the humerus, though the after-treatment requires more care than usual.*

* See Clinical Cases at end of section.

LECTURE LI.

Fracture of the Shaft of the Humerus—Diagnostic appearances and symptoms—Above insertion of Deltoid—Transverse and Oblique Fractures—Mode of Treatment—Fractures of Humerus near Elbow-joint—Difficulties of Diagnosis—Method of Examining, and Treatment—Dislocation of Elbow—Of both Bones—Of Ulna—Of Radius—Method of Reduction—After-treatment.

Fractures of the Shaft of the Humerus are of very common occurrence, and, as a rule, very easy of diagnosis. They are generally accompanied by a marked shortening and distortion of the limb, and, in most cases, crepitus can be readily elicited. When the fracture occurs between the insertions of the pectoralis major and latissimus dorsi above, and the deltoid below, the displacement is almost always in one direction. The two former muscles draw the upper portion of the bone towards the chest; whilst the latter, acting on the lower portion, draws it upwards and partly outwards, so that it lies to the outer side of the upper part of the bone. In such a case no special treatment is required; all that is necessary, after adjusting the fracture is to apply well-padded splints on the outer and inner sides of the arm (Plate xvi. Fig. 7). The arm should be flexed at right angles, but the elbow unsupported by the sling, so that the upper arm may be allowed to hang straight down. If this treatment be maintained, there will be no great danger of displacement recurring. When the fracture happens near the middle of the humerus, the displacement differs in different cases, being generally regulated by the direction of the obliquity, so that, if the fracture be transverse, there is often little or no displacement. In an oblique fracture the fragments glide in one or other direction, according to the direction of the oblique surfaces, so that the muscles by their contraction simply produce short-

ening of the limb, while the overlapping of the tapered ends of the broken bone produces the distortion. In such cases, by extension and counter-extension, coaptation can be readily effected.

In treating fractures of the shaft of the humerus, the elbow should be unsupported, so that the weight of the lower part of the arm may act as an extending power. On the other hand, in fracture of the surgical neck of the humerus, the elbow should be supported; if it be not, the weight of the upper arm may drag away the large lower portion of the humerus from the small upper fragment, as stated when speaking of the treatment of that fracture.

In fractures of the humerus lower down, in the neighbourhood of the elbow-joint, most careful attention is required in forming a diagnosis, more especially if the patient be young. In children there is a very great tendency to the occurrence of dislocation at that part, and in them we also meet with separation or diastasis of the articular ends of the bone from the shaft, and these two accidents bear a close resemblance to each other. In this region we meet with splitting of the condyles, sometimes in one direction, sometimes in another. These injuries are attended with immediate swelling; a great deal of effusion takes place into the joint at an early period, and renders the difficulty of diagnosis very great unless the parts be examined immediately after the accident. We require to be very careful in our examination of such cases, for on making an accurate diagnosis everything depends. If we have to do with a dislocation, we can easily reduce it at once; but if we fail to do so, thinking the injury is a fracture, the consequences may be very serious. If we find the arm of a child shortened and swollen before and behind, and if we find that we can neither flex nor extend the elbow, the probability is that we have to deal with a dislocation. In most cases we have a guide which should prevent us from mistaking a dislocation for anything else, even when there is much swelling. In the natural state of parts, when the arm is semi-flexed, the point of the olecranon is much below the

level of the internal condyle of the humerus. Now, by feeling along the back of the bone, and pressing inwards when there is swelling, we discover the inner condyle projecting from the condyloid portion of the shaft. We then trace backwards to the olecranon, and if we find that the point of it is lying at a lower level than the internal condyle, we may conclude that the injury is not a dislocation of the ulna. Or we may examine to ascertain if the condyles and articular surface of the humerus be thrust in front of the bones of the forearm, as the hard rounded projection so caused is in general very perceptible. If we should find that there is so much swelling behind and in front that we cannot trace these relations, we next extend the arm, as in treating a dislocation, and try to reduce the parts. If the injury happens to be a diastasis of the articular ends of the bone, we shall be able in this way to bring the parts into their natural position. As soon, however, as we leave off the extension and counter-extension, the deformity will return, thus showing that the injury is a separation of the epiphyses from the condyloid portion of the shaft. This can be done even when there is much swelling present, if we put the patient under chloroform—as we ought always to do. In manipulating, we should first extend the limb fully, and then bend the forearm upon the upper arm. If this can be done to such an extent that the hand can be forced backwards so as to touch the point of the shoulder, and if we can again extend the forearm freely upon the upper arm without any shortening, then we may safely conclude that, if the injury was a dislocation, we have succeeded in reducing it; whereas, in the case of a fracture, we should, by the same means, elicit crepitus very distinctly.

In cases of oblique fracture through the condyles, we sometimes cannot make out the crepitus readily if we lay hold of both condyles with one hand, for in that case we would be holding the broken parts together. We should therefore handle them separately. Fracture of the outer condyle, or lesser head of the humerus, resembles dislocation of the head of the radius backwards, that bone being carried back along with the

broken fragment. But the crepitus and the ease with which the parts are brought into position show us what the injury really is.

One mode of treatment is suitable to all these fractures about the condyles. This consists in placing a pad of wadding in the bend of the elbow, retained in position by a figure-of-eight bandage round the joint; and this is all that is required. The arm should be kept at a pretty acute angle, to prevent separation of the fragments, and to prevent the muscles which arise from the condyles of the humerus from drawing the broken condyle downwards.

Dislocation of the Elbow may occur in different ways—generally from the patient falling with the hand extended or the arm semiflexed.

The most common dislocation is that of both bones backwards. In this condition the arm is semiflexed, or rather less, there is a projection backwards and a swelling in front. The forearm is shortened and altered in form, becoming more rounded than usual. This dislocation is easily discovered on careful examination, though it is not so obvious as might be supposed from seeing it merely on the skeleton. The best diagnostic is the projection of the condyles in front forming a swelling there, and the altered relation of the inner condyle to the olecranon, which now lies above instead of below it. We take the relations of the olecranon and inner condyle as our guide, and tracing down the shaft of the humerus in front, we suddenly come upon a swelling at the elbow, and then we find the radius and ulna situated much more deeply than their usual place. In position, the arm is nearly semiflexed; and, though we cannot fully flex it, we can often bring it to a right angle. Neither can we extend the arm fully. Having made out this dislocation, the mode of reduction is next to be attended to. We are told that the best method is to bend the bones of the forearm over our elbow or knee, placed in the bend of the patient's elbow. This will not always enable us to effect reduction. If, however, we first extend the hand and forearm backwards, we shall then have merely the point of the

coronoid process touching the humerus, and there will then be very little opposition to reduction. The best plan therefore is to extend the hand and forearm backwards, and when the parts yield a little, then flex. In children this dislocation is generally very easily reduced.

In dislocation of both bones, backwards and laterally, either to the outer or inner side, the displacement is much more marked than in the former case, but the symptoms are much the same. There is the shortening of the limb, and the projection before and behind the elbow, as already described.

In some cases we have the ulna alone dislocated, the radius remaining *in situ*. The injury is readily enough ascertained from the ulna projecting very far back, and the olecranon lying higher up than usual. The mode of reduction is the same as in dislocation of both bones backwards, and by pressing on the bones laterally, at the same time that we extend we facilitate the reduction. So also in the two former dislocations, besides using extension and flexion, we may apply direct pressure on the ends of the bones, so as to assist the extending power.

The radius may be dislocated by itself, either backwards or forwards. In fracture of the outer condyle of the humerus we have appearances very like those exhibited in the former of these. In the dislocation backwards the annular ligament and the external lateral ligament are torn, and the head of the bone plays on the back of the outer condyle. In dislocation forwards, on attempting to flex the arm we feel a sudden check; the roundness of the forearm is very marked.

The mode of reduction is slightly different in the two dislocations. In the dislocation forwards the forearm should be drawn downwards and outwards, and the hand supinated as far as possible, so as to rotate the head of the radius outwards from its abnormal position. By acting through the medium of the hand, we obtain power over the radius. In the dislocation backwards we extend the arm and then attempt to pronate the hand and flex the forearm. So far as the mere reduction goes, it is easy enough if the case be seen early. In dislocation of the

head of the radius backwards or forwards the head of the bone has a great tendency to slip out again after it has been reduced. It is articulated in such a way, that before dislocation can take place the annular ligament must be torn, and the lateral ligaments also partially or entirely separated. These ligaments take a long time to unite ; and if the patient begins to move the arm too soon, the head of the bone is almost sure to slip out. Hence, after this dislocation, the arm must be bandaged as it is in cases of fractures of the condyles, and kept quiet for a longer period than is generally necessary in other dislocations.

LECTURE LII.

Fractures of Bones of Forearm—Of the Olecranon—Causes of different degrees of Displacement in different cases—Method of Treatment—General Mode of Union—Of Coronoid Process—Fracture of Shaft of Ulna—Difficulties of Coaptation and Retention—Fracture of both Bones of the Forearm—Near Wrist-Joint, simulating Dislocation backwards—Method of Treatment—Fracture of the Radius above Bicipital Tubercle—Above insertion of Pronator Quadratus—Above Styloid Process—Displacing Causes and method of Treatment—Dislocation of the Wrist—Method of Diagnosis and Reduction—Fractures and Dislocations of the Metacarpal Bones and Phalanges—Dislocation of Thumb—Fracture of Metacarpal Bones—Compound Fracture of Fingers.

We shall now consider the fractures occurring in the bones of the forearm, and first those of the ulna.

Fracture of the Olecranon Process of the ulna is generally the result of direct violence, the bone snapping across just at the middle, or nearer the point of that process. The resulting displacement is very marked. The portion broken off from the shaft of the ulna is dragged upwards by the action of the triceps muscle, leaving a distinct interval between the broken surfaces. If the arm be kept nearly straight, the interval is less visible; but if it be flexed the gap becomes widened, and leaves a well-marked space between the broken ends of the bone. The amount of separation will depend on the extent to which the internal lateral ligament of the elbow-joint is detached from the bone. Some of its fibres are attached near to the point of the olecranon, and if these fibres are not torn through, the inner side of the upper fragment will be kept pretty nearly in contact with the shaft of the ulna, and will not be dragged upwards by the triceps. This portion of the internal lateral ligament used to be called the ligament of Sir Astley Cooper, who described it in his

work on fractures. If the ligament be completely torn through, the displacement will be much greater, for in that case there is nothing left to resist the action of the triceps. In most cases the fracture is readily enough detected—even when the displacement is not very great—from the mobility of the small upper fragment. In some cases the bone may be split obliquely or almost longitudinally, so that we have the two fragments of the olecranon attached to the tendon of the triceps, and therefore not separated by it.

In transverse fracture of the olecranon we meet with the greatest amount of separation. When the fracture is detected in time there is no difficulty in effecting co-aptation. To do this the limb has to be straightened, in order to bring the ulna as far back as possible, also to relax the triceps, and so approximate the upper fragment to the shaft. The two separated portions are thus brought into as close contact, as possible, and in order to keep them so, we place the arm extended, and apply a splint in front, sufficiently long to reach from the middle of the upper arm to the middle of the forearm. Sometimes a longer splint is required when we wish to fix the hand and wrist. The splint is secured by a roller and the usual figure-of-eight bandage round the elbow (Plate xvi. Fig. 12).

We are sometimes advised to put on the figure-of-eight bandage first, and then apply the splint and secure it, so as to have the ends of the bone dragged together accurately by it. If we attempt to do too much at first we are not likely to succeed so well as if we proceed more gradually. The fracture is attended with much effusion and swelling into the joint. The upper fragment floats, as it were, on the fluid, and so long as the effusion is there we cannot expect absolutely perfect coaptation, and therefore we should not try, by the figure-of-eight bandage, to force the parts into contact. We should apply the retentive apparatus lightly at first, allow the swelling to subside, which it soon does, and then re-apply the bandage and splint more firmly, so as to keep the limb perfectly straight, and prevent all flexion.

Sometimes we have to deal with a fracture of the lower part of the humerus along with a fracture of the olecranon. This happens occasionally, though not often. In such cases we must make a sort of compromise in our treatment. The best method of dealing with the humeral fracture would be to keep the arm at a right angle. This would cause a wide separation of the broken portions of the ulna, and we are therefore obliged, in order to meet both conditions, to keep the arm bent at an obtuse angle. Under any circumstances this is a difficult accident to treat properly.

In fracture of the olecranon we find that the union is generally by ligamentous texture and not by bone. This does not affect the usefulness of the limb afterwards, if the bone be well set, for then the ligamentous texture is short and firm, and, indeed, the great object is to have the uniting medium as short as possible. The same thing occurs in fracture of the patella.

Fracture of the Coronoid Process of the ulna sometimes happens, in which that portion of the process giving attachment to the brachialis anticus is separated from the ulna. The brachialis anticus retracts to a certain extent, and the small fragment is drawn upwards by it in front of the arm, and so forms an obstacle to flexion of the limb. The joint also projects backwards in flexion, for want of the check afforded by the process and its attachments to prevent the ulna from going back, and this may give the appearance of dislocation of the ulna alone without the radius. On attempting flexion, we find that we cannot easily accomplish it, in consequence of the position of the upper fragment. On bringing the bone into position again, we can produce crepitus, showing that it is a case of fracture. This injury is very rare, and it is very obscure when it does occur. Some surgical authors state that dislocation of the ulna backwards cannot take place without fracture of the coronoid process; but I have never seen a case of that dislocation in which the coronoid process was broken. The way to treat fracture of the coronoid process is to flex the limb, and place a pad of wadding in the bend of the elbow, supported by a figure-of-eight bandage.

Fracture of the Shaft of the Ulna may occur at any point. It generally happens low down, but sometimes, from direct violence it may be broken high up. If the fracture take place along with a corresponding fracture of the radius, the treatment is not difficult. If the ulna alone gives way above, or at its middle part, without fracture of the radius, there is sometimes great difficulty experienced in treating it, for in that case we have no power to act directly on the bone so as to bring the displaced fragments into position. The muscles acting on it draw the different portions of the bone inwards, thus narrowing the interosseous space and curving the bone on itself. In a similar fracture of the radius, without a corresponding fracture of the ulna, we can act on the broken bone by extension through the medium of the hand ; but, in connection with the ulna, we have no such power, and sometimes in a muscular limb there is very great difficulty in bringing the fracture into accurate position. The displacing causes in fracture of the shaft of the ulna are the various muscles of the forearm. The pronators and supinators draw the bone inwards and twist it, while the flexors and extensors shorten it. When the fracture is lower down, the displacement is not so great, and there is not so much difficulty in the treatment. The other conditions are the same.

In fracture of both radius and ulna together, the displacement and the difficulty of treatment are less. Here we have a command over the broken bones through the hand and forearm and we can thus bring the fragments into accurate apposition. We require to be very careful in the after-treatment of these cases, for the muscles of the forearm have a constant tendency to draw the bones inwards towards the interosseus space, and if union take place in that position, the motions of pronation and supination will be prevented. Splints, therefore, must be carefully applied. They should be broader than the arm, that the bandage may not act on the sides of the bones, and so force them in towards each other, and a pad must be placed in front over the interosseous space. This tends to force down the muscles into the interosseous space, and helps to prevent displacement

of the bones in that direction. The forearm should be placed between pronation and supination, and the elbow kept at a right angle. The posterior splint should reach from beyond the elbow to the point of the fingers, and another shorter splint is placed in front of the limb (Plate xvi. Fig. 13).

The nearer the fracture is to the wrist-joint, the greater is the deformity which results. In fracture of both radius and ulna close to the wrist-joint, we have an injury resembling dislocation of the hand backwards. There is swelling both on the back and in front of the wrist. The forearm is shortened, and the hand, together with the lower fragments of the radius and ulna, lies on a plane very far behind the general line of the fore-arm. In this case there can be little difficulty in the diagnosis, because by slight extension and counter-extension we reduce it, and cause distinct crepitus. The treatment also is very simple. Well-padded splints are applied in front and behind. The forearm and the elbow are kept slung at a right angle.

Fractures of the Radius alone are much more common than those of the ulna. The highest fracture of the radius is that which occurs a little below the insertion of the biceps. In this position the small upper fragment becomes flexed upon the arm, and somewhat supinated by the action of the biceps, so that it projects, and can be sometimes readily felt. In most cases, however, there is very little displacement, and the difficulty often is to make out the fracture. The patient complains of pain on attempting to flex or move the arm. When we put the arm straight, we can feel the line of the radius apparently entire. The best way of ascertaining the presence of such a fracture is by rotating the fore-arm, and at the same time making examination with your hand placed on the back part of the elbow, where the head of the radius is very slightly covered. On the outside there are muscles covering it, but there are none posteriorly, and in that part we can feel the movements of the head of the bone in pronation and supination very readily. If we find on rotating the radius that the head of the bone moves

along with the hand, then there is no fracture. We may have it move for a time very nearly synchronously with the hand, in consequence of the two fragments lying in close apposition, still it is not the same smooth movement that there is if the bone be entire. Again, by fixing the shaft of the radius and ulna, and moving the upper part of the radius, we can make one fragment touch the other, and then crepitus is felt.

The treatment of this fracture consists in placing the forearm in splints, which should be somewhat narrower than those used for fracture of the ulna, and keeping the arm bent at a right angle.

There are two special fractures of the radius lower down —above and below the pronator quadratus. The more common of these is that which takes place immediately above the styloid process.

In the higher fracture, the hand falls in and is pronated. There is a swelling in front and behind. The pronator quadratus and the pronator teres, together with the extensors and the supinator longus, are here the chief displacing causes. The supinator longus tilts up the styloid end of the radius. The pronator teres cannot draw forwards and inwards the upper fragment readily, because it is counteracted by the supinator brevis, and this fragment lies therefore nearly in position. The biceps also tends to prevent this portion of the bone from being rotated inwards, so that in this fracture we have, as a general rule, the lower fragment lying in front of the upper, being rotated towards the ulna, by the almost unopposed action of the pronator quadratus.

In the lower fracture we meet with the very opposite condition. In it the lower fragment invariably lies behind. The displacing causes are more numerous than in the former case. We have the pronator quadratus, or at least the greater portion of it, above the site of the fracture; the few fibres which are connected to the lower fragment are so injured that they do not act. In this fracture the muscle rotates inwards and pronates the upper portion of the radius, whilst the supinator radii longus

tilts up the lower fragment, and the long extensors of the thumb and index finger draw back the hand along with the lower fragment, and so drag it obliquely upwards behind the shaft of the bone. It cannot pass in front, because the shaft has been rotated in front by the pronator quadratus. The general shortening is caused, as before, by the action of both flexors and extensors. The displacement is very marked in this fracture. The styloid process of the ulna naturally lies on a line with the posterior aspect of the hand, but in this fracture it seems to project in front. The hand is drawn backwards and outwards, and from the lower fragment lying behind, we have the appearance of dislocation of the hand backwards and outwards. This displacement is caused by the hand, which is connected to the styloid process of the radius, being drawn back along with it. The ulna is really lying in its natural position; it is the hand that is drawn away from it. This fracture is very common, but it is one requiring a great deal of care and attention in the treatment. The injury to the muscles and tendons and their sheaths causes great stiffness afterwards, and it is sometimes weeks, or even months, before the patient gets the use of the hand again, from the effusion into the sheath of the tendons, and the consequent stiffness. The fracture is apt to be attended with great displacement, and the bones must therefore be placed and kept in accurate position, the tendency of the small styloid fragment being to be drawn backwards.

There are several different methods of treating this fracture. Sir Astley Cooper recommended placing the forearm and hand between two long, straight, and rather narrow splints, and then allowing the weight of the unsupported hand to counteract the tendency of the bone to be displaced upwards. The principle of this is good, but it is not a certain method of bringing about a cure. In some cases we can treat this fracture perfectly well by bandaging very carefully so as to keep the hand in this position. The patient instinctively supports the dependent hand, and so is sure to move it, and therefore I generally use slightly curved or angular splints to keep the hand in position—the slope beginning

just at the wrist-joint (Plate xvi. Fig. 14). The splints should reach to the tips of the fingers, and should be less padded in front of the radius than on its posterior aspect. The limb is then carefully bandaged and kept thus for about three weeks, when the splints should be taken off and shortened, and the passive movements of the finger-joints should be begun. These passive movements do not affect the fractured portions of bone. After about four or five weeks we may begin slight passive movements of the wrist-joint, taking care while doing so to hold the arm firmly at the fractured point. If we keep the arm up in splints for six weeks or more, till the bone is thoroughly united, the fingers and wrist become so stiff that the patient may not be able to use them for a long time.

Dislocation of the Wrist.—I have seen but one dislocation at the wrist-joint, and that was one of old standing. I used to be very doubtful as to the existence of such a dislocation, for most of the cases reported as such I have found to be cases of fracture. The one alluded to was really one of dislocation. In our diagnosis between dislocation, and fracture immediately above the styloid process of the radius, if we take as our guide the base of the metacarpal bone of the thumb and the styloid process of the radius, we find that in the fracture the distance between these two points does not vary—they remain in their natural relative positions. The hand and the lower fragment of the bone have been both drawn upwards and backwards, but there is no displacement of the carpus upon the radius. In the dislocation, however, this is very marked. The metacarpal bone is much higher up, and the styloid process is felt to approach the metacarpal bone in front, causing swelling in that position. There is also a swelling behind, from the rounded mass of the carpus projecting posteriorly. In the radial fracture we have no alteration in the relative position of the metacarpal bone of the thumb and the styloid process of the radius, and we have not the swelling in front caused by the projection of the large articular end of the bone, so that we can scarcely mistake one injury for the other. Moreover, in the dislocation, once reduc-

tion has been effected, the displacement does not recur; whilst in the fracture, as soon as the extension and counter-extension are left off, the parts again become displaced.

The reduction of this dislocation will be easily accomplished by extension and counter-extension, drawing forward or backward the hand, according as the dislocation is behind or in front of the bones of the forearm. All the after-treatment required is to keep the parts in position for a few days with a bandage.

FRACTURES AND DISLOCATIONS OF THE METACARPAL BONES AND PHALANGES have next to come under our notice.

DISLOCATIONS OF THE THUMB are not uncommon, and their reduction is sometimes difficult on account of the small size of the portions of bone on which we have to make extension. In dislocation between the proximal phalanx and the metacarpal bone of the thumb, the head of the bone is generally thrust back and the lateral ligaments of the joint remain still entire or twisted, and in that position they constrict the head of the bone. This dislocation is the most common one in my experience. The under surface of the proximal end of the phalanx lies fixed on the posterior aspect of the metacarpal bone, where it causes a projection so evident that there can be no difficulty in diagnosing the injury. I have generally found little difficulty in reducing the dislocation; but still I know that such a difficulty has been met with, and it may occur in any case where the ligaments are only partially torn, and where the head of the bone has been thrust back forcibly between them, and fixed and constricted by their agency. In one of Mr. Liston's cases, he was compelled to divide the lateral ligaments before he could reduce the dislocation; but in most cases we can do so by drawing upon the end of the bone, depressing the point of the thumb forcibly, and drawing it downwards and forwards. By putting the patient under chloroform, we are able to get rid of all muscular opposition. Once the dislocation is reduced, all the treatment required is to apply a bandage round the thumb, and keep the hand quiet for a few

days. The same treatment is applicable to dislocations of the fingers.

Fractures of the Metacarpal Bones are generally easily detected, though in some cases they are rather obscure, especially if only one bone has been broken, and more particularly if that be the metacarpal bone of the ring or middle finger. In such a case we have crepitus only when we press on the particular bone which is broken, because the other metacarpal bones act as lateral supports and keep it in position. Fracture of the metacarpal bone of the little finger is very easily made out.

The best way of putting up these fractures is to make the patient grasp a ball of soft worsted or tow in his hand, and then bandage up the hand in that position. The neighbouring bones act the part of splints. In certain cases we require to keep the hand straight, and then we apply a splint in front along with a bandage. In two or three weeks the fracture is completely united and no deformity results.

Compound fractures of the fingers generally require amputation on account of the accompanying laceration of the joints, tendons, and soft tissues.

Fractures and other injuries of the bones of the cranium and face, and those of the spine and trunk, I shall reserve for consideration under the head of Regional Surgery, as the complications arising from the implication of important organs are in these injuries the features of greatest interest.

Plate XVIII

DISLOCATION

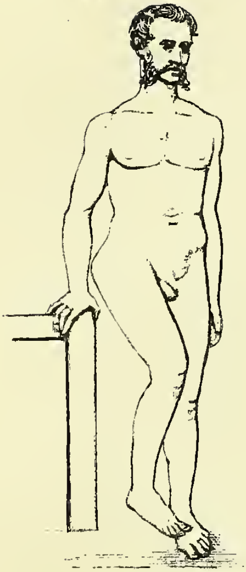


Fig 1.

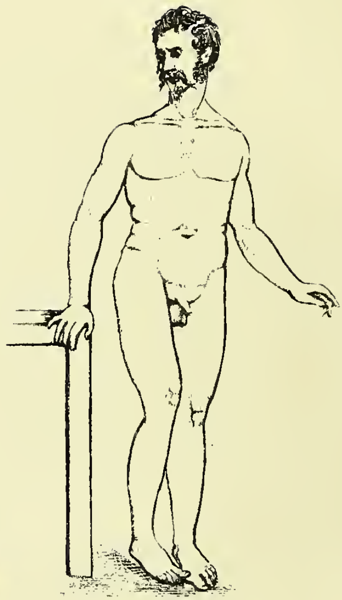


Fig 2.

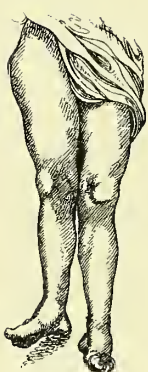


Fig 5.

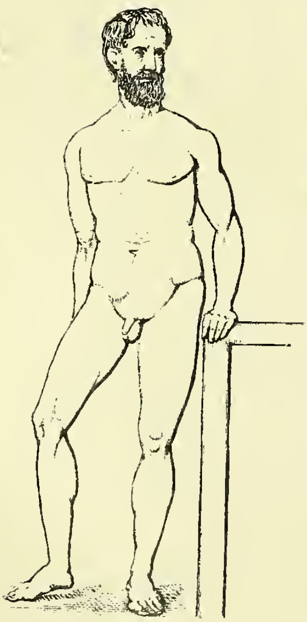


Fig 3

Fig 4

LECTURE LIII.

Fractures and Dislocations of the Lower Extremity—Dislocation of the Hip-Joint—On the Dorsum Ilii—Into the Sciatic Notch—Into the Obturator Foramen—On the Pubis—Diagnostic Symptoms and Methods of Treatment.

We shall now proceed to discuss the fractures and dislocations of the lower extremity, commencing in this instance with the dislocations :—

*The Dislocations of the Hip-Joint are four in number—two backwards, one downwards, and one forwards and slightly upwards. The two first are dislocation upwards and backwards on the dorsum of the ilium, and backwards and slightly upwards into the greater ischiatic notch. We shall consider these in the order of their frequency.

In dislocation of the head of the femur on the dorsum of the ilium, the knee and foot are turned inwards, the trochanter is felt further back and higher up than usual, and the head of the femur lies on the dorsum of the ilium. This is the most common of all the dislocations of the hip. There is shortening of the injured limb to the extent of one or two inches at least. The knee is inverted, the foot rests on the upper part of the tarsus of the opposite foot, and there is a great bulging at the hip from the projection of the trochanter. There should be little difficulty in diagnosing this dislocation, as there is only one fracture for which it can be mistaken, and that is more likely to be confounded with a dislocation of the head of the femur into the ischiatic notch.

Dislocation of the head of the femur into the greater ischiatic notch is somewhat rare. It sometimes occurs as a secondary dislocation when we are reducing the one already spoken of, or

* See Plate xviii. Figs. 1, 2, 3, and 4.

the dislocation downwards into the obturator foramen, but it also occurs as a primary injury.

The symptoms of dislocation into the ischiatic notch are somewhat similar to those attending dislocation on the dorsum ilii. The head of the femur tends to fall into the ischiatic notch, but is prevented from entering by the muscles which fill it up. It catches upon the edge of the ischiatic ligament and other textures, and pushes the softer tissues before it. There is a projection posteriorly, though to a less extent than in the former injury, and lower down. The limb is slightly bent, and inverted towards the opposite one, but does not tend to cross over it, as it does in luxation on the dorsum ilii. It is shortened, but much less so than in the former case, and the foot rests on the metatarsal bone of the great toe of the opposite foot. The knee is inverted, and touches the inner side of the opposite knee. Thus, there is much less deformity, and the symptoms are less marked than in dislocation on the dorsum of the ilium, and more care is therefore required in the diagnosis. In all these dislocations we have one diagnostic mark—namely, the immobility of the limb as regards the natural movements. The limb is fixed at an angle, and we cannot move the femur from the os innominatum, unless we move both bones together. Hence, in these two dislocations, if we lay the patient flat in bed we find that when his back is perfectly straight, the limb is raised up and turned inwards. If we bring the limb down, as we can do with force, we make the back arch, and if we lay the back flat, the limb rises again. In the dislocation on the dorsum of the ilium this is one of the best diagnostics we can have. It is due to the angle at which the bone is fixed. Some speak as if this symptom were only referable to the dislocation into the ischiatic notch, but it is really less marked in that than in the other luxation. It is, however, more generally spoken of in reference to the dislocation into the ischiatic notch, for that injury is much more difficult to diagnose than the other, and therefore this diagnostic symptom is of more value. In both these injuries, therefore, we have

somewhat the same symptoms—obliquity and shortening of the limb, with inversion of the knee. In the dislocation on the dorsum of the ilium the deformity is greater and the swelling of the trochanter is much more visible. In dislocation into the ischiatic notch the symptoms are less marked, and the diagnosis, as well as the treatment, is more difficult.

In dislocation backwards the injury is caused by great force. No fall directly upon the trochanter would be likely to give rise to a dislocation. It occurs either by the patient coming to the ground with the knee bent while the body is still in motion, or more frequently from falls of earth, or the like, upon the patient whilst he is stooping. It always requires a very considerable amount of indirect violence, with a certain position of the body and limb at the time, to cause these dislocations, for it requires great force to rupture the strong ligaments of the hip-joint. They are not uncommon accidents, though by no means so common as fractures in this region, which may be caused by a much less degree of force. The dislocation may sometimes be accompanied by fracture of the pelvis, from the kind of force causing the injury, as, for example, in pit accidents, or by a person falling from a great height; and then the prognosis is very unfavourable from the injury to the pelvic viscera, which is almost always present.

In the reduction of these dislocations the direction of the force should always be in the direction of the axis of the dislocated bone, the pelvis and trunk being fixed. As a general rule, the lacque should be fixed above the knee-joint, so as to act on the femur directly, though I have often succeeded in reducing a dislocation by fixing the laque above the ankle when I have failed to do so with it placed above the knee. Still, as a general rule, we should begin with the laque fixed in that position. In reducing luxation on the dorsum ilii, the force should be dirccted in such a way as to carry the bone obliquely downwards and forwards. A sheet is placed round the limb, and an assistant draws laterally on the bone so as to tilt the head and neck from off the surface of the ilium, in order that the

force acting on it may meet with less obstruction. In this way the head of the bone often slips readily enough into the acetabulum.

In dislocation into the ischiatic notch the direction of the extension is somewhat the same, only more oblique. We require, in drawing upon the bone, to keep it away from the notch. The difficulty of reduction is greater in this luxation, and is partly due to the ligamentous textures. The head and neck of the bone also come in contact with the rounded surface of the os innominatum, near the acetabulum, thus causing an obstruction to the reduction. By tilting the head of the femur from the notch, whilst extension is made downwards and forwards, and the pelvis kept fixed, the reduction can generally be effected, though with a little more trouble than in the dislocation on the dorsum of the ilium. When the dislocation into the ischiatic notch occurs secondarily in reducing other luxations, there is generally no difficulty in effecting its ultimate restoration. The difficulties are much greater when it is a primary dislocation, especially if some time has elapsed after the receipt of the injury. We can sometimes reduce the dislocation with the hand when the case is seen early. This, however, does not often happen, in consequence of the great bulk and muscular power of the thigh. As a rule, therefore, when there is any difficulty, instead of wasting time in attempting to reduce the dislocation by the hand, we should try it with the pulleys, and in drawing on the bone with pulleys we must take care to keep up the force steadily and evenly, and not in jerks. You can sometimes facilitate the process of reduction, by bending the knee across the opposite leg to a still greater extent than it has already assumed. You thereby make it act as a lever, by which the head of the bone is drawn outwards from its lodgment on the dorsum of the ilium, and where otherwise it would be firmly retained by muscles and other tissues. It is also occasionally advantageous to alter the directions of the force, and to rotate with the same object, for often during reduction, after the first part has been effected, the head of the bone may be checked in its course by becoming locked at the ridge of the acetabulum.

Plate XIX

DISLOCATION

The method by "manipulation," as recommended by Dr. Reed of Rochester, U.S., has been employed successfully in reducing these dislocations in some cases. The patient is put under chloroform, and then by flexing the leg on the luxated thigh, carrying it across the sound one, flexing it slowly upwards over the pelvis to the umbilicus, then abducting and rotating outwards, the reduction is accomplished.

The other two dislocations of the hip are comparatively rare.

Dislocation of the head of the femur into the obturator foramen is the more common of the two. Here we have also symptoms of a very marked character, though perhaps not quite so striking at first as we might imagine from looking at the skeleton. This is the only dislocation in which the lower limb is lengthened. The lengthening is due to the position of the head of the femur, for it lies below its natural level. The foot points directly downwards, or is slightly everted, and the limb seems to lie away from the other. When the patient is lying flat on his back we find that we cannot bring the injured limb parallel to and in close contact with the sound one; and we cannot cross it over the opposite thigh without reducing the dislocation. I have seen what seemed to be an exception to this rule in the case of a patient who was very much in-kneed; but such exceptions are rare. There is another thing which strikes us on looking at the limb—namely, a depression corresponding to the point where the great trochanter was situated, instead of the elevation of the trochanter seen in the two former dislocations.

There are some cases which it is possible to mistake for this dislocation. The late Mr. Liston met with one of these in which the patient had suffered from incipient disease of the hip-joint, and had fallen on the hip, causing swelling and all the appearances of dislocation. Mr. Liston asked him if he had ever been lame on that leg, and found that at the age of twenty he had been. I have had a similar case in my own hospital practice. I have also seen in young patients separation of the head of the femur, which might be mistaken for a dislocation;

but, apart from such cases, there is seldom any difficulty in diagnosing this injury. The method of reduction is simple. The pelvis is fastened by a sheet, and then another sheet is placed under the injured limb towards the upper part of the thigh, and brought over the neck of the assistant. The limb is extended a little at first, but not very much, for it is already longer than usual. We only extend it so as to overcome any muscular resistance, and then draw it inwards across the opposite limb, using the foot and leg as a lever to tilt the head of the femur outwards from the thyroid foramen. In this way the dislocation can easily be reduced. If we were to extend the limb in this case obliquely downwards and outwards, we would not be likely to reduce the dislocation, for we would be pressing the head of the bone away from the acetabulum.

Dislocation on the pubes is very rare indeed. The symptoms are shortening of the limb, eversion of the foot and knee, and a swelling felt upon the pubes where the head of the bone is lodged. I have never seen a case of this kind in the early stages, though I have seen an old case of unreduced dislocation on the pubes. The head of the femur lies upon the pubes, and on rotating the limb we have a very evident swelling in front. This stretches the vessels of the part and presses upon them to some extent, causing a certain amount of congestion. The heel also inclines towards the opposite one. This dislocation is said to resemble ordinary fracture of the neck of the femur, where there is eversion of the foot and knee, as in the dislocation. There should, however, be no difficulty in the diagnosis, for in the fracture we have not the head of the femur forming a swelling on the pubes. This dislocation is not to be reduced in the same way as the others. We must, in this case, extend and tilt the bone in a particular way. The patient is placed on the opposite side, and here it will not do to draw straight down. The extension must be made backwards, so as to tilt the head and trochanter away from the pubes. After the extension has been continued in this direction for some time with slight rotation, the head of the bone will slip into the

acetabulum ; but it is useless to attempt reduction by drawing straight down at first.

After any dislocation has been reduced, the limbs are fastened together by a bandage, with a pad of wadding between the knees and ankles. Then a broad bandage or flannel roller is placed round the pelvis and firmly secured, so as to keep the parts perfectly quiet for some time, and allow the capsular ligament to unite as far as possible. If there be much swelling in the neighbourhood, opiate fomentations must be applied, especially if great force has been required to reduce the dislocation. The bad symptoms generally pass off very soon, and in from four to six weeks the patient may be allowed to use the limb. If motion be allowed before that time, there is always a risk of the recurrence of the dislocation from the weakness of the capsular ligament.

When the dislocation is accompanied by a fracture of the pelvis, it is a very different matter, then the prognosis is always unfavourable.

LECTURE LIV.

Fracture of Neck of Femur—Intra and Extra Capsular—Diagnosis and Modes of Treatment—Fractures of Shaft of Femur at different parts—Directions and causes of Displacement—Treatment.

Fracture of the neck of the femur, or separation of the head of the bone from the trochanters, occurs in a variety of ways, and may be caused by comparatively slight force. The fracture may be completely within the capsule of the joint, and it is then called intra-capsular. Or it may occur external, to the reflection of the synovial sac, and also in a great measure beyond the principal attachment of the capsular ligament, in which case it is called extra-capsular fracture. Or it may partake of both characters, being partly intra and partly extra capsular. The subjects of it are generally persons well advanced in life.

The general symptoms of this fracture, whether intra or extra capsular, are very similar after a time, so much so that there is some difficulty in making out distinctly whether it is intra or extra capsular. If the case be seen immediately after the accident has been sustained, there are diagnostic symptoms which help us to distinguish the two injuries. We have shortening of the limb, eversion of the foot and knee, swelling about the trochanter, and great projection in that region.* These symptoms occur in all cases of fracture of the neck of the femur, whether intra or extra capsular, after some time has elapsed, say from twenty-four to forty-eight hours. But in a purely intra-capsular fracture the symptoms are at first much less marked. There is eversion of the foot and knee, but there is very little shortening of the limb, not more than half-an-inch or so, and there is not much swelling at the hip. Sometimes it is very difficult to elicit crepitus. This is due partly to the depth at which the bone

* Plate xviii. Fig. 5.

lies, and partly to the fact that blood and synovial fluid are effused between the broken ends. Then the two portions of the broken bone are not likely to correspond with each other, so that you might roll about the bone for a long time without ever bringing the fractured surfaces into contact.

The reason why intra-capsular is not marked at first by so much shortening as extra-capsular fracture is, that in the extra-capsular fracture all the muscles which draw up the lower part of the thigh act upon it directly and at once, so as to make the displacement visible from the first, the capsule of the joint being torn through. Whereas in the intra-capsular fracture the capsular ligament surrounding the head of the bone attaches the two fragments so far to each other, and it is only after some stretching of the ligament that the lower portion is drawn upwards and outwards. Hence, when there is marked shortening of the limb and trochanteric projection at the very first, the probabilities are that the fracture has taken place below the capsule, and the case may therefore be safely diagnosed as one of extra-capsular fracture, but when the shortening does not occur for some time, then we may consider it to be an intra-capsular fracture.

Mr. Smith, of Dublin, in his work on fractures, draws attention to the cervical ligament of the femur, and considers that that texture prevents the immediate shortening in the intra-capsular fracture, but it seems to me that the attachment of the strong resisting capsular ligament is the real obstacle. It is important to know whether the fracture be intra or extra capsular, for if it be the latter, we have a very good chance of obtaining bony union, and then the limb again becomes useful, whereas in intra-capsular fracture osseous union is exceedingly rare. Indeed, it is very doubtful whether the fracture ever unites by bone. In old people, it is not always advisable to persist in keeping on splints at the risk of the general health. If we know that we have to do with intra-capsular fracture, we have less hesitation in leaving off the special treatment ; whereas if the fracture be extra-capsular, we are warranted in persisting, even at some little

risk to the general health, in keeping on the retentive apparatus. The eversion of the foot and leg, and the shortening of the limb, are generally explained thus :—The shaft of the bone, with the trochanters and neck, are drawn upwards and backwards towards the pelvis by the gluteus, medius, and minimus, whilst the digital fossa, into and near which the external rotator muscles are inserted, being situated also in the trochanteric portion of the bone, the shaft of the femur is everted by these external rotators, which have no muscles to counteract them. It is perfectly true that the external rotators and glutei are the muscular causes of the shortening and eversion; but the weight of the limb causes eversion, as we see when there is no fracture, for when a person is lying on his back the limbs are naturally everted. The difficulty of feeling crepitus depends, as already stated, on effusion of blood and synovial fluid within the joint and between the ends of the bone; but more generally this difficulty arises after shortening has taken place, and where there is considerable swelling. In the extra-capsular fracture, where the trochanter is considerably drawn up, if we rotate upwards and inwards, we are not likely to cause crepitus, because then we do not make the broken surfaces of the bone meet, and it is only after extending the limb and then rotating that we can feel it. I have always found that the best method of eliciting crepitus is one which may be considered perhaps rather a rough plan. It is to bend up the limb forcibly, and then extend it suddenly downwards. We thus loosen the portions of bone from each other, and so produce crepitus very readily; but sometimes we do not require to adopt this plan when there is not much shortening.

As regards the results of intra-capsular fracture of the neck of the femur, it generally unites by fibrous texture. The uniting medium is a cartilaginous matrix with fibrous texture in it, and although thin, is pretty strong. Even after this fracture, therefore, a tolerably useful limb may sometimes be left. In some few cases we find very unfavourable results. The head of the femur may become necrosed, and suppuration take place within

the joint, leading to irritative fever and death of the patient. This result, of which I show you a specimen, is exceedingly rare. I have never seen a case of it during life, although it is, I think, remarkable that we so seldom meet with such cases. The head of the bone is broken off completely from the shaft. All the small vessels which pass into it must have suffered great injury from the fracture, and its only vascular supply is derived through the vessels of the ligamentum teres.

Certain cases of fracture at the neck of the femur may be mistaken for dislocation of the hip. In ordinary intra-capsular fracture the symptoms are somewhat like those seen in dislocation of the head of the femur on the pubes. No one, however, could mistake the two injuries, for in the dislocation we have the head of the bone projecting on the pubes, and we have also a certain amount of congestion in the limb, caused by the pressure of the head of the bone on the vessels in the neighbourhood. There is, however, a fracture of the neck, or upper part of the femur, which occurs chiefly in old people, and which simulates dislocation of the hip backwards. The force causing the fracture may be very slight, perhaps a mere fall in a room, generally on the hip. In the fracture just mentioned, the limb is shortened to a slight extent, the toes rest on the metatarsus of the opposite foot, the limb is drawn up, but the hip not so much swollen as in the ordinary fracture of the neck of the femur, and the knee is inverted, not everted as in that injury. This fracture is not a very common one. Its direction is very oblique, passing through the neck of the femur in front, close to the trochanter. The greater portion of the trochanter and the digital fossa posteriorly are left in connection with the head and neck of the femur. The external rotator muscles have nothing to counteract them, and therefore rotate the head of the bone outwards, while at the same time they draw the trochanter upwards and backwards. In front, again, if any part of the glutens medius be left in connection with the shaft, it is only its anterior fibres, and these, along with the tensor vaginæ femoris, act as internal rotators, and turn inwards. This readily

explains the inversion of the knee. In this fracture the appearances at first are very like those of dislocation of the head of the femur into the ischiatic notch, but whenever we extend the limb it becomes everted, the toes turned out, all the signs of dislocation disappear, and then we see the true nature of the injury.

In chronic rheumatic arthritis we may have all the symptoms of fracture of the neck of the femur, but the history of the case should guide us in our diagnoses. As fracture of the neck of the femur occurs chiefly in old people, the first question for the surgeon to consider, with reference to *treatment*, is: Can the patient bear the application of retentive apparatus without great constitutional irritation? I should say that if the long splint be carefully applied and well padded, it will give more rest to the patient than could be obtained by leaving the limb loose. Therefore the long splint should be applied for the first few days at least. If the patient complains very much of the restraint arising from it, then it must be taken off. If this be necessary, then the limbs should be brought together and fastened by a bandage, a pad being placed between the knees and ankles, and then a broad flannel spica-bandage round the hip. This will not prevent some degree of shortening, but we must try and keep the limb as quiet as possible when the patient cannot bear the splint. In some cases we may put the limb on a double inclined plane of pillows, and fix it so, the knee being bent at an angle. In this way the weight of the body is made to act as a counter-extending force. This method was recommended by Dupuytren, but I have not found it very efficient. The patient is restless, the pillows get displaced, and he often suffers much irritation from the movements of the fragments upon each other. Hence, when I can use the long splint I always do so, and if the patient cannot bear it, then I keep the two limbs fastened together as just described. In applying the long splint in such cases we do not use any force in extension and counter-extension. By padding the splint well, and placing the patient on a water-pillow, we find that, in a great many cases, the

long splint may be kept on for the first eight or ten days. Afterwards it may be taken off, if necessary, for separation of the ends of the bone is not likely to take place after that time. If no constitutional symptoms require the removal of the splint, it should be left on as long as possible, and I must say that there are very few cases in which the splint cannot be applied, if proper care be taken. Bandaging the two limbs together is just a way of making the sound limb act as a splint for the broken one. In some cases I have applied the splint on the sound limb, and then fastened the broken limb to it with advantage.

In Fractures of the Upper Part of the Shaft of the Femur the displacement is very great. The nearer the fracture is to either extremity of the femur the greater is the difficulty in the coaptation of the end of the bone and the treatment of the fracture. This is due to our having no power whereby to act on the smaller fragment, or to overcome the action of the strong muscles attached to it. In fractures high up in the thigh, for example, the upper fragment is elevated by the iliacus and psoas muscles, and the shorter this portion is the more power these muscles have in displacing it, and the less power we have in controlling them. When the fracture is lower down, the upper fragment has still a tendency to be drawn upwards, but not nearly so much as in the higher fracture. In treating these fractures we must be very careful to bring the fragments into accurate position at first, and therefore, I think, it is advisable to put the patient thoroughly under chloroform, then extend the limb and set it very carefully, and apply the proper splints and bandages at once. In almost all fractures of the femur I prefer the long splint to any other retentive apparatus ; in this fracture it can be assisted by the use of short splints, so as to prevent the elevation of the upper fragment. A small Gooch's splint is padded and placed on the front of the thigh to prevent the elevation of the upper fragment, and another is placed posteriorly, while extension and counter-extension are kept up by the long splint. Some surgical authorities say that we should treat these fractures on

the double-inclined plane, the angle of which should be made as acute as possible, and in this way the weight of the body lying flat in bed would act as a counter-extending power. I have never found this method answer very well in practice for keeping the parts in position. Whatever apparatus we apply we shall find great difficulty in this respect, but with the double-inclined plane the difficulty is greater than with the long splint.

There are a variety of forms of displacement in fractures near the middle of the femur. The upper fragment may be the riding end of the bone, and the lower end may project upwards and inwards, or upwards and outwards. If the fracture be low down the inner condyle will be tilted inwards, while if it be a little higher up it will be tilted outwards. These variations, in form of displacement, depend on the relations of the adductors to the point of fracture. In very oblique fractures the oblique planes of bone tend to glide upon each other, and we have the lower portion dragged upwards by the hamstring muscles, causing shortening of the broken bone, independent of the lateral deformity, and in such cases we require to be very accurate in the co-aptation of the fragments. In transverse fractures of the shaft of the femur we can bring the two portions into accurate contact, and they can easily be kept in position, the one portion acting as a check to the other; but fractures are generally more or less oblique, and the slightest muscular power tends to move one fragment on the other. In all cases of fracture of the shaft of the femur I use the long splint for the purpose of keeping up the extension and counter-extension that we have already got, but we are not to use it as a sort of rack to extend the broken limb. We may put on anterior and posterior or lateral Gooch's splints, as well as the long splint, so as to prevent any antero-posterior or lateral displacement. In transverse fractures of the shaft of the femur, where the one fragment checks the other, there would not be much likelihood of displacement after the fracture had been set. In oblique fractures the slightest force or movement tends to cause the bones to glide upon each other, and the use of

the retentive apparatus is just to prevent this. The long splint must be applied on the principle of keeping up a moderate amount of extension. I should not like to treat any fracture of the femur without the perineal band, which acts both as an extending and counter-extending power, preventing any slight shortening which might otherwise occur, and unless we use it we are very apt indeed to have shortening of the limb.

LECTURE LV.

Fracture of Condyloid Extremity of Femur—Displacing Causes—Treatment—Description of the method of using the Long Splint and Double-Inclined Plane in the different Fractures of the Femur—Fractures of the Patella—Displacing Causes—Method of Treatment—Evulsion of the Ligamentum Patellæ—Its Diagnostic Appearances—Nature and Treatment.

In fracture of the lower end of the femur, near its condyloid extremity, the displacement is very characteristic. The lower fragment is invariably drawn backwards behind the upper, which remains very nearly in its natural position. In some cases from the action of the tendon of the adductor-magnus, the upper end of the lower fragment is thrown a little outwards. When the fracture is close to the condyloid portion of the femur, the lower part is bent directly back towards the leg. The cause of this displacement is the action of the gastrocnemius and popliteus muscles, which are attached to the lower part of the femur, dragging it back towards the leg. These muscles are not counteracted by any of the extensors in front, as the latter all pass over the joint. When the fracture is very low down, the small lower fragment is bent back on the leg to such an extent that it is very difficult to bring it in line with the upper part of the femur. In treating this fracture, the great point is first to bring the parts as nearly as possible into apposition. In order to do this, we generally require to put the patient under chloroform, so as to overcome all muscular resistance and enable us to model the broken parts accurately together. We then stretch the leg downwards and press the lower fragment upwards, so as to bring it into contact with the shaft of the bone. A padded splint is then placed behind, but the pad must not press directly into the popliteal space, lest it interfere with the circulation.

Its use is to prevent in some degree the lower fragment from being drawn backwards again. The limb is then put straight, and the long splint applied. The fracture can be generally very well treated in this way, though in some cases there may be a difficulty, and therefore some prefer the double-inclined plane to the long splint. For my own part I always use the latter, with a Gooch's splint behind the fracture. In fractures of the condyloid portion of the femur, splitting or fissure into the knee-joint is not uncommon. It is a very unfavourable complication.

I would now direct your attention to the use and mode of applying the long-splint and double inclined plane in cases of fracture of the thigh.

The former is a long wooden splint, reaching from the axilla to about four inches beyond the heel, with holes bored in it at the top and bottom. This is rolled up in a sheet, which should be thick enough to form a pad as it is rolled round the splint, a part being left free to encircle the limb and splint. The limb is brought straight, and the splint is laid along the outer side of it in readiness to be fastened there by means of the sheet. The perineal band consists of a handkerchief passing under the perineum and tied through the holes in the upper end of the splint. The holes in the bottom of the splint are for fixing it to the foot by means of a handkerchief. The sheet is then brought round and pinned, so as to fix the limb. A broad flannel bandage placed round the body so as to keep the splint perfectly fixed, completes the apparatus. In fracture of the neck of the femur, this is all that is required. In fractures of the shaft, two Gooch's splints are padded and placed laterally—one on the outside, the other on the inside of the thigh, and fastened there with slip-knots; the knots being always tied over the inner splint. The perineal band is the most important part of the apparatus. It forms a counter-extending power as we draw it up, and it also forms an extending power from its being fastened to the upper end of the long splint, and forcing it down when tightened. We must take care not to attempt to extend by tightening the handkerchief at

the foot, for if we do, we push up the long splint, and with it the lower fragment of the femur, and so certainly cause shortening of the limb. The slip-knots must be tied on the inner side of the limb, for if tied on the outside, whenever they require to be tightened or loosened, the long splint must be so far displaced, which is avoided if the knots are on the inner side. Sometimes the long splint is fastened to the limb by a bandage instead of the sheet; but this is very troublesome, because when we want to look at the fracture we are obliged to undo the whole bandage. The sheet should be fastened with pins, so that we can then examine the fracture without displacing the splint (Plate xvii. Fig. 1).

I wish to take this opportunity of stating more fully my views regarding some principles to be attended to, in treating fractures of the shaft of the femur with the long splint. Doubtless, in every case, the careful setting of the fracture at the first, making sure that the broken limb is fully the same length as the sound one, and that there is no obliquity of the pelvis, or other source of fallacy, which might deceive as to the apparent length, is all important and essential. No one can be more opposed than I am to the use of the long splint as a rack to elongate forcibly an imperfectly adjusted fracture of the femur. On the other hand, I am equally convinced that, however well adjusted at first, there will be great danger, almost certainty, of retraction and shortening, unless we keep up the extension we have effected, for the first ten or fifteen days at least. In a fracture of the femur, the extensor and flexor muscles alike tend to shorten; and as the displacing muscles are pretty equally balanced, we cannot relax them as in treating a simple fracture of the leg. Hence, if the extension and counter-extension be not kept up, the muscles tend to draw the broken fragments over each other. If all fractures of the femur were transverse, so that the broken surfaces, when properly adjusted, would serve to check each other when lateral displacement was prevented by the lateral splints, or if muscles ceased to act whenever the fracture was set, then our plans of treatment might be much simplified. Unfortu-

nately, fractures of the femur are often oblique, and the opposed planes tend to glide upon each other and produce shortening from very slight movement, and muscles contract and cause displacement even after the most careful adjustment. For these reasons, I hold that we must take means to prevent such shortening by *keeping up the extending power, not increasing it—merely keeping the advantage we have obtained*—and all that is required for this purpose is to keep tight the perinæal band at the upper part of the splint, which, by pressing down the splint, retains the limb of the proper length. I have more than once seen surgeons proceed to increase extension by tightening the handkerchief or bandage which fastens the foot to the lower part of the splint, the effect of which is simply to push up the splint, and with it the lower broken portion, and so cause shortening. If the lower bandage requires to be re-adjusted, extension and counter-extension should either be made by assistants, as when setting the fracture originally, or else firm counter-pressure should be made by an assistant pressing down or fixing the splint from above whilst the foot bandage is being tightened.

In adjusting fractures of the femur at first, I make it a rule that the fractured limb should be fully half an inch longer than the sound one, so as to allow for the yielding of the intervening articulations of the knee and ankle.

The double-inclined plane, or Liston's splint, is an improvement on M'Intyre's splint.* When applied it should be well padded, so that the limb may rest *on* rather than *in* the splint. The lower part of the splint is fastened to the bed, or slung. Care must be taken not to let the patient's heel fall through the large opening at that end of the splint. A slip of bandage should be placed across it to prevent this. In this splint the weight of the body acts as a counter-extending power. It answers very well in certain fractures of the thigh, but, as a general rule, I prefer the long splint in these cases. For, if the lower end of the femur should come below the angle of the splint, it would be projected upwards, and cause deformity, if not

* Plate xvii. Fig. 5.

remedied. In certain fractures of the leg, this is the most useful of all splints, especially if the fracture be either compound or comminuted.

Fracture of the Patella is very common, and results from the patient falling or receiving a direct blow on it. The fracture may be either transverse, oblique, or stellate. In transverse fracture of the patella the two fragments are widely separated from each other, the upper being drawn upwards by the quadriceps extensor femoris, and if the thigh be flexed the distance between the fragments is increased. In the stellate and oblique fractures the different portions of the bone are attached to the ligamentum patellæ, and also to the quadriceps extensor, and there is therefore no displacement, whereas in the transverse fracture the displacement is very marked. Fracture of the patella is analogous to fracture of the olecranon in the upper extremity. The fragments do not often unite by bone, but by a strong fibrous texture. The usefulness of the limb afterwards, depends a great deal on whether the uniting medium be long or short. If it be long, there will be very little use of the limb afterwards. If it be short, the limb will be as useful as if the union had been by bone. In fact, I have seen a second fracture occur through the bone, while the fibrous uniting medium of the former fracture had not given way. Fracture of the patella, like that of the olecranon, is one of the most simple to treat. All that is required is to place the limb on an inclined plane, the heel must be raised, the foot fixed, and the limb slung.* After a few days we can put up the fracture in a long Gooch's splint, with a bandage from the foot to above the patella, the limb being slung as before. This position relaxes the quadriceps extensor, and allows us to bring the fragments into pretty accurate contact. At first there will be a good deal of swelling, and therefore we cannot attempt to drag the two fragments forcibly together. We must wait till the effusion disappears, which it very soon does, and then we can act on the fragments and try to force them together by a figure-of-eight

* Plate xvii. Fig. 2.

ate XVII

FRACTURE.

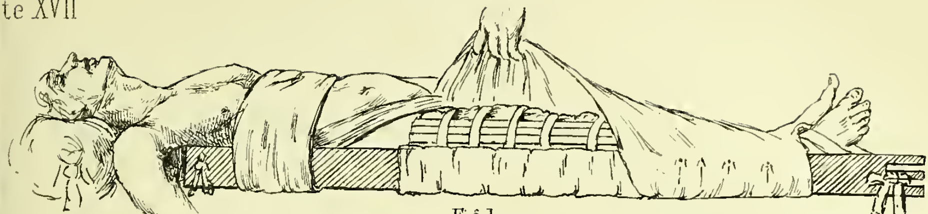


Fig 1.

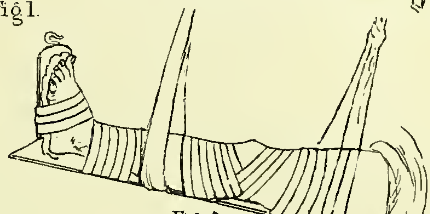


Fig 2

Fig 3

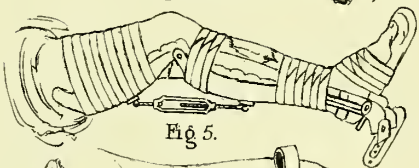


Fig 5.

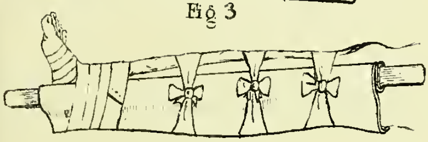


Fig 4

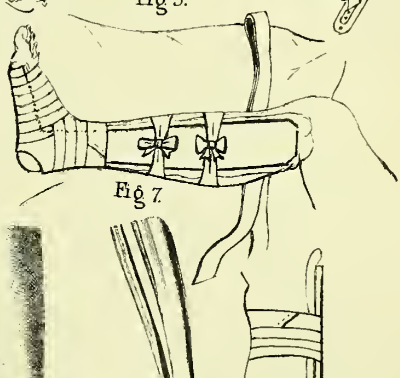


Fig 7.

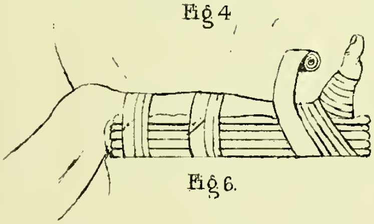


Fig 6.

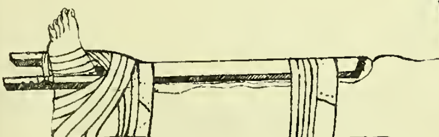


Fig 8.

Fig 9.

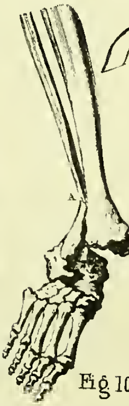


Fig 10.

Fig 11.

Fig 12

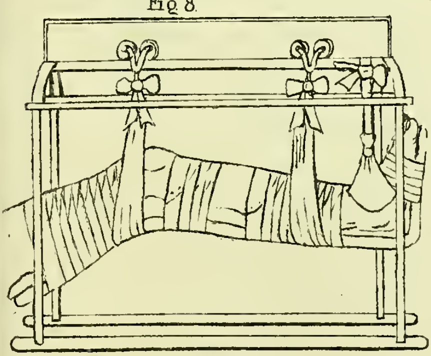


Fig 13

bandage, which will keep the parts in position quite as well as any special apparatus.

Evulsion of the Ligamentum Patellæ is a rarer accident than fracture of the patella. Some say it may be mistaken for fracture, but in the rupture of the ligament of the patella the whole bone is drawn up in front of the thigh, and with it a portion of the ligament, while, in the fracture, the lower fragment is always distinct and movable. Immediately after the accident happens a good deal of swelling occurs. There may be a slight projection of the upper part of the tibia, but it is not movable, and cannot be mistaken for the lower fragment of the patella. This injury seems to arise from violent action of the extensor muscles of the thigh. The patient, by a violent effort, tries to save himself from falling, and the knee at the time being bent very forcibly, the violent contraction of the quadriceps extensor causes the evulsion of the ligament of the patella. The treatment of this injury is exactly the same as that of fracture of the patella, though it is a little more troublesome. Because in it we have no two fixed points to bring together, and therefore we must employ a little lateral pressure. The limb is placed on an inclined plane, and slung and bandaged as before, but here we require to take care to prevent the ligamentum patellæ from forming a new adhesion laterally. In fracture of the patella there is not this risk. The parts must be kept in very accurate position, and the limb on the inclined plane, for at least seven or eight weeks, which is longer than is necessary in fracture of the patella. In fact the limb ought to be kept in the straight position by means of a splint or starched bandage for some time afterwards, so as to prevent any muscular action affecting the newly-united parts.

LECTURE LVI.

Dislocations of the Knee-Joint—Risks attending the Injury—Mode of Reduction—Question of Primary Amputation or Resection—Diastasis in Children simulating Dislocation.

Fractures of Bones of Leg—Transverse and Oblique Fracture of both Bones immediately above the Ankle—Different methods of Treatment—Fracture of Fibula at its Upper and Lower Parts—Pott's Fracture, with Dislocation—Fracture of the Internal Malleolus—Methods of Treatment—General Remarks.

Dislocations of the Knee-Joint are not common; when they do occur, the force causing the injury is generally such as to necessitate amputation, for the popliteal vessels are usually much injured. In some few cases we do meet with dislocation of the condyles of the femur from the tibia without serious complication, and then our treatment is limited to attempting to reduce the dislocation and save the limb. In the first instance, even though the circulation behind the knee may be interrupted, we cannot be sure the popliteal vessels are injured, for the condyles of the femur may be pressing on them so as to stop the circulation temporarily. Lesion of the vessels does generally occur in this injury, but not necessarily so, and when the dislocation is not compound, that is, when there is no opening into the knee-joint, we should always try to reduce it. After the reduction the circulation should be restored at the ankle, and if it does not return soon after the pressure has been removed and the shock has passed off, then lesion of the popliteal vessels has probably occurred, and the question of amputation has to be considered.

In compound dislocation we generally find the popliteal artery and vein twisted and torn from the great amount of force causing the injury, whilst there is often a considerable

amount of bleeding from the smaller vessels. In other cases when the skin is cut through, and the condyles of the femur project while the vessels remain uninjured, the question of excision must be considered. When there is nothing to contraindicate this operation, and when circumstances enable us to treat the patient properly, it is certainly far preferable to amputation, and causes less shock to the system, but it is not suitable in cases where the soft textures around are much injured.

The appearances of dislocation of the knee-joint vary in different cases. For example, the condyles may be turned outwards and the bones of the leg thrust backwards, the patella being drawn inwards. In such a case reduction could be effected easily enough by extension and counter-extension, and then flexing the limb. When the dislocation has been reduced, the limb must be kept quiet for some weeks by means of a splint and bandage. Afterwards, gentle passive movement of the joint should be begun, lest the parts should become stiff from fibrous anchylosis.

Another injury which is very likely to occur in young children, and which might be mistaken for dislocation of the knee-joint, is diastasis of the condyloid portion of the femur. All the injuries about the knee-joint are comparatively rare, but if the case be seen early, the above rules ought to be followed out, and applied according to circumstances.

Fractures of the Bones of the Leg are amongst the most common accidents in surgery. They occur either from direct or indirect violence. If from the latter, then the weakest parts of the bones give way. For example, should the fracture occur by the patient jumping from a height, it generally takes place at the neck of the fibula and low down in the tibia; but the lower part of the fibula is likewise weak, just opposite where the tibia is fractured, and it often gives way there also, so that then the fibula is fractured in two places, as in this specimen. The fracture may, however, occur at any point. In young subjects especially we meet with a direct transverse fracture of the tibia and fibula with little or no displacement,

so much so that the diagnosis is often difficult, but in this case we make the bones move laterally, and we can then feel crepitus. In other cases the displacement which occurs is very marked. In oblique fractures, whether the obliquity be in the antero-posterior or in the lateral direction, the displacement and shortening are very great. If the fracture be oblique from behind upwards and forwards, there is great displacement of the lower fragment, the foot and heel being drawn back by the action of the gastrocnemius and soleus. If the fracture occur transversely, close to the tubercle of the tibia, there is no displacement forwards of the lower fragment, but the upper portion is raised and tilted forwards by the action of the extensor muscles. If the tibia be fractured about the middle, the projecting ends of the bone can generally be felt readily. As we approach the malleolar portions of the bones, the fractures become much more complicated. Separation of one malleolus is apt to be attended with considerable displacement, and separation of both malleoli is always attended with great displacement of the foot backwards. When the bones are broken transversely, immediately above the malleoli, the lower fragment with the foot are retracted, while the shafts of the bones are pushed forwards.

In fracture of both bones of the leg about the middle or upper part, the bones must be accurately adjusted at first, and in the oblique fractures the treatment must be very careful throughout.

The general method of treatment which I adopt, and which I find far the most satisfactory in fractures of both bones of the leg, when they are not very oblique, and when there is not any very great displacement, is to apply two lateral pasteboard splints. The limb is flexed and laid on the outside, and the splints, which are first moulded to the limb, are then applied. In applying them we should see that the greater part of the foot-piece corresponds to the sole of the foot. The sole-piece is of great assistance in keeping the foot in proper position at right angles to the leg. A figure-of-eight bandage to above the ankle secures the foot-piece completely; a narrow pad is placed

in front, and slip-knots are applied to keep the rest of the splint in position (Plate xvii. Fig. 7). The advantage of this plan is, that we can trace the line of bone in front, and see how the fracture is lying without disturbing it. If we find that the heel gets drawn backwards, or that any other displacement occurs, the splints must of course be re-adjusted. The limb requires to be bent at different angles according to circumstances. When the fracture is towards the lower third of the leg, or when there is a tendency to retraction of the heel, the leg must be flexed towards the ham, so as to relax the gastrocnemius, which is the chief displacing cause. When the fracture is higher up, we do not require to flex the limb so much. By attending to these rules, and by keeping the splints carefully applied, you will find this to be the best and simplest method of treating simple fractures of both bones of the leg.

When we have a very oblique or comminuted or compound fracture, or where the fracture is very high up, Liston's splint, well padded, answers better (Plate xvii. Fig. 5), as giving greater power of extension and preventing the fragments moving on each other. The foot should be supported by a handkerchief placed under the heel, and this should be fastened to a hook in the foot-piece. I object to the application of a continuous roller round the splint, for then we cannot tell how the limb is lying without undoing the bandage. It is far better to have a few slip-knots, or interrupted circles of bandage, and then we can see how the fracture lies, and can adjust any little displacement, if it occur, without much trouble. As a general rule, in all cases of fracture of both bones of the leg, the position of the limb should be such that the ball of the great toe and the inner edge of the patella are in a line with each other. There is one rule which I would lay down regarding this splint—namely, that in all fractures at or below the middle of the leg the thigh-piece should be brought as much as possible to a right angle with the leg-rest. In oblique fractures the upper portion of the tibia gradually becomes forced down, causing displacement; and the remedy for this is to increase the angle of the splint, and sling

the foot so as to prevent the thigh from pressing downwards. We should not let the patient see how the angle of the splint is adjusted, for he is very apt to alter it himself, as every splint feels irksome at first. Another point is, that the foot-piece should be as nearly at a right-angle as possible.

Liston's splint answers very well also for fractures about the malleoli; and if it be necessary to apply lateral splints, that can be done without any difficulty. There is another method of putting up simple fractures of the leg, which I often adopt, for it is one, the apparatus for which can always be got very readily, and it answers the purpose very well. It consists of two thin flat pieces of wood or lath, which should be of a sufficient length to reach from the bend of the knee to beyond the heel. These are rolled up in a sheet so as to form two lateral splints. A folded towel is placed as a pad in front of the limb, and the apparatus is then fastened with slip-knots and a figure-of-eight bandage round the ankle (Plate xvii. Figs. 3 and 4). The splints should reach well below the foot, so as to allow us to fix it properly; and the leg should be placed on a pillow, or slung with the knee considerably bent. The leg is not laid on its side, but lies on the posterior aspect. This apparatus answers in most cases where we would use the double-inclined plane, and is of great use in emergencies. In all cases of fracture of the leg, whether Liston's, or the lateral splints be used, the limb should be fastened to the bed, or slung so as to prevent the patient from moving it.

In fractures low down a posterior splint is sometimes applied to prevent the heel from being drawn backwards. In other cases an anterior splint is necessary. This latter is called the "stirrup splint;" it is used in cases where the malleolar portions of the tibia and fibula are broken, the foot drawn backwards, and the upper fragment of the tibia pushed forwards. The stirrup splint is well padded, and applied on the front of the limb, fastened on with slip-knots and a bandage at the ankle, the bandage being brought under the heel. This is most important. For if we apply it higher up, we are apt to cause greater displacement, as

we do not then bring the heel forwards to the splint (Plate xvii. Fig. 8).

The stirrup splint answers admirably also in dislocations at the ankle-joint, in preventing any return of the displacement. If there be any tendency to lateral displacement, we may prevent that by applying two narrow pasteboard splints, so as to give lateral support, while we also press the heel forwards. In these cases there is often inversion or eversion of the foot, and by the use of the stirrup-splint we can prevent the retraction of the heel, and at the same time turn the foot either inwards or outwards, by using the outer or inner horn of the splint as a fulcrum over which to turn the foot. If we want to evert or invert the foot, to prevent displacement recurring, we can do so with the stirrup-splint without applying any other apparatus. This form of splint is certainly that which gives most power in drawing the heel forwards, and in keeping back the bones of the leg; but, unfortunately, in many cases, which would otherwise be suitable for it, we cannot apply the stirrup-splint, from the injury to the soft parts in front, which is often present, and on account of which the patient cannot bear the pressure in front. Before the stirrup-splint came into use, Baron Dupuytren's plan was that generally adopted—namely, a posterior splint. When there is great retraction of the heel, with bruising on the front of the leg, then we may apply two lateral pasteboard splints, somewhat narrower than usual, so as to prevent any lateral displacement, and a well-padded Gooch's splint at the back of the leg, which keeps the heel into position, and prevents any possible retraction (Plate xvii. Fig. 6).

When the fibula alone is fractured, at the upper or middle part, we can hardly tell that there is a fracture, for it generally occurs transversely, and the fragments are kept in position. The fracture gives rise to pain only on movement, and is attended with very little displacement or swelling. In fracture of the fibula low down, immediately above the external malleolus, there is very great displacement, at least under certain circumstances. We may have fracture of the fibula about an inch and a half

above the malleolar extremity, with very little displacement and with no eversion of the foot; but if, along with this fracture of the fibula, we have separation of the internal lateral ligament from its malleolar attachment, or if that ligament be torn to any extent, then we find that the displacement is considerable, the foot is turned round, and the sole looks outwards. This injury is called Pott's fracture and dislocation (Plate xvii. Figs. 9 and 10). It only occurs when the fracture of the fibula happens along with separation of the internal lateral ligament. The peronei muscles then meet with no resistance, and act on the foot so as to turn it outwards. The foot is, however, readily replaced, and the limb can be brought into accurate position; but we must take care to keep up the inversion of the foot, for the peronei muscles have always a tendency to turn it outwards, and so cause a falling-in of the upper end of the malleolar fragment of the fibula. If the internal malleolus be broken off and the external lateral ligament torn, the foot is inverted, though the displacement is not so great as in the former case, the displacing causes in this accident being the tibialis anticus and the flexor muscles passing behind the inner ankle. If we have the mere point of the external malleolus broken off, whilst there is no injury to the tibia, we sometimes have slight inversion of the foot. In fracture of the external malleolus, with laceration of the internal lateral ligament, the foot is displaced outwards. In fracture of the internal malleolus, with rupture of the external lateral ligament, the foot is displaced inwards. The method of inverting and everting the foot, to keep the bones in position, is very simple. Pott used the simple lateral wooden splints, and these with foot-pieces, keep the foot in very good position. Still there is a tendency to eversion of the foot, and therefore Dupuytren's splint is the one generally used for these fractures of the malleoli. This splint reaches from the knee to two inches or so beyond the ankle. It is padded with a sheet which is folded double opposite the ankle, so as to form a soft fulcrum. Supposing the fibula to be broken, and eversion of the foot to have occurred, our object will be to

invert the foot; the splint is therefore applied on the inner side of the leg, and kept fixed by slip-knots in the usual way (Plate xvii. Figs. 11 and 12). The part of the foot to be acted on is just above the projection of the fifth metatarsal bone, and we should act on the transverse arch of the foot, not on the heel. In this way we can see the position of the limb at once by looking at the foot. When there is inversion of the foot from fracture of the internal malleolus, and where therefore we want to evert the foot, we must apply the splint on the outside of the limb. When there is great separation of the bones of the foot, with retraction and inversion, we may use the stirrup splint, as already stated, by which the foot can be inverted and everted, just as with Dupuytren's splint, whilst retraction of the heel is prevented.

With exceptional instances, I have always employed these simple methods so long and successfully used in this hospital; and after very extensive experience in treating fractures in hospital, dispensary, and private practice, I see no reason for changing to other methods, which certainly could not afford me better results, and which seem to me attended with some risk, from which these ordinary plans are free. I allude, particularly, to the use of the starch bandage and the plaster of Paris methods of treatment, which are now much used on the Continent. In regard to the dextrine or stucco bandage applied after the lapse of some weeks, when all risk of swelling or other results of the local irritation produced by the accident have passed away, and, as a means of abridging the period of the patient's confinement, I not only have no objections to it, but have recourse to it very generally. But, used from the very first, I think it objectionable, as preventing the surgeon from observing the state of the limb, and guarding against mischief. The advantage which some claim for it, that the patient may walk about with a crutch in a day or two after the injury, I look upon as no advantage; but, on the contrary, I think the patient would be then much better in his bed, even supposing he felt the inclination to walk about. The plaster of Paris method, of course, has all the

disadvantages of hiding the fractured limb from the surgeon's view; and, if I may judge from personal experience, when working with that material in taking casts, it must be anything but pleasant to the feelings of the patient when it contracts in setting. I have seen a considerable number of cases of fracture of the leg put up in this manner in Germany, and I can easily understand that many such cases do well enough; but it is quite as likely that in many cases the mass of stucco in which the fractured limb is embedded, may be, very literally, a whited sepulchre. In a word, I think when we possess well-tried, simple, and successful plans of treatment, we should be very chary in departing from them. Novelty is not always progress, and unfortunately many novelties in surgery at the present day seem to consist in departure from simplicity of treatment.

LECTURE LVII.

Dislocations of the Ankle—Methods of Reduction and After-Treatment—Compound Fractures about the Ankle—Risks—Question of Amputation—Conservative Treatment—Dislocation of the Astragalus—Dislocations of the Tarsus—Fracture of the Os Calcis—Complications in Consequence of the Nature of the Accident—Fractures of the Metatarsus.

THE DISLOCATIONS OF THE ANKLE are two. One in which the bones of the leg are thrust forwards, while the foot is drawn backwards. The other, in which just the opposite displacement occurs, the bones of the leg being thrust backwards, and the foot drawn forwards. The former injury is the more common of the two. It very closely resembles fracture of the malleoli, with retraction of the foot; but on careful examination we find, that the malleoli are entire, and the tibia and fibula unbroken, showing that there is no fracture, but simply dislocation with laceration of the ligamentous textures. A very great amount of force is required to cause this injury, and it is much more common to meet with the fracture than with the dislocation. When the injury does occur, however, it is easily enough recognised and treated, and it is less troublesome as regards the after-treatment than the fracture is.

When you are about to attempt to reduce the dislocation, put the patient under chloroform, so as thereby to get rid of the opposition of the gastrocnemius and soleus muscles. Then extend the foot, and counter-extend the bones of the leg, pushing them backwards at the same time if they are dislocated forwards. In this way the dislocation can generally be very easily reduced, and once reduced, there is little or no tendency to displacement recurring, for the malleoli, which retain the astragalus in position naturally, are kept on either side of it; but to avoid

risks, a bandage is put round the foot, and a splint placed either before or behind the limb, according to circumstances, and kept there for a short time. When the bones of the leg are thrust backwards upon the os calcis, there is sometimes a little more difficulty in reducing the dislocation than in the former case, where reduced retentive apparatus is applied to prevent displacement, as in the other dislocation.

In Compound Fractures and Dislocations about the Ankle.—I am convinced that, whilst we may occasionally obtain very good results, in the greater proportion of cases the results are so disastrous, that, as a rule, amputation is better than attempting to save the limb. In many cases the external injury is apparently very slight. The external wound may be small, and we may be able with very little force to replace the parts in position. Splints are applied, and the case may go on very well for a week or two, but then irritative fever sets in, with abscesses and erysipelatous action about the parts. Even in cases which ultimately do well, these bad symptoms come on, causing great risk to life. I have had five very successful cases, of this injury in adults; but on looking back to those cases, and considering the dangers the patients ran, and the long time they took to get well, I have come to believe that, as a general principle, it is safer to amputate the foot. I know that, in many cases where I have attempted to save the limb under as favourable circumstances as in these five successful cases, the results were fatal. It is seldom that we can perform secondary amputation, on account of the fever and pyæmia which set in. Therefore in the adult at or above middle life, in compound dislocations and fractures at the ankle joint, we should, as a rule, amputate rather than attempt to save the limb. But if we are to try conservative measures, we must proceed on certain principles, and in children and young persons I would always endeavour to save the limb, unless in very scrofulous patients; but I would not be content with simply reducing the dislocation and keeping the parts in position. I would take care, if it was a small wound, to enlarge the opening, and remove the cartilage

of incrustation from the surface of the tibia, from the internal surfaces of the malleoli, and from the upper part of the astragalus. I would also remove any loose, torn portions of the synovial membrane, then bring the parts into position, so as to get the surfaces of bone into contact, and so make it rather a compound fracture than a compound dislocation. This is the plan I would recommend, but in people above middle life I must say that my few successful cases recovered with so much danger to life that I would advise amputation rather than any attempt to save the limb.

Dislocation of the Astragalus sometimes happens from a person falling with great force upon the heel. The astragalus is thrust forwards, and completely dislocated from the other bones of the tarsus. At other times it is partially broken through, and in most cases it is almost impossible to reduce the bone—some, indeed, have declared it to be utterly impossible. In these cases I generally recommend that an incision should be made, and the loose bone be removed at once ; but at the same time there are cases in which I have seen the bone reduced, and I would therefore always attempt reduction before making an incision to remove the bone. There is a difference of opinion as to whether the bone, when irreducible, should be removed immediately, or whether a certain amount of inflammation should first be allowed to supervene. The advocates of the latter plan say that nature has altered the joint by this time, and the removal of the bone would therefore not be likely to set up irritation ; but I think the best way is to remove the bone at once, provided that it cannot be reduced, and afterwards employ the ice treatment, which I would advise as giving a better chance of success than any other plan, especially in young subjects, where there is a very fair chance of a good recovery by this means. The astragalus may be thrown to the outer or inner side of the foot, and in a few cases we may effect reduction by extending the foot and pushing up the astragalus.

Dislocation of the Tarsus is not very common, but I have seen it occur, and I have also seen it reduced after it had existed for

some ten or twelve weeks. This was done by dividing the tendons which prevented its reduction. A very useful limb was left. When the dislocation is recent the reduction is not a difficult matter.

Fracture of the Os Calcis is not an uncommon injury. It is caused by a person falling from a height with great force upon the foot. Sometimes the bone is simply broken across, or it may be split up and comminuted. In most cases the injury is a severe one, not only from the bone being broken up, but also because the very degree and kind of force causing the accident are likely to cause some injury of the head, so that there is generally concussion, and not unfrequently symptoms of fracture of the base of the cranium. We must, therefore, look to more than the local injury.

In some cases the tibia is split up, as well as the os calcis broken, and in most cases, even when the fracture is simple, necrosis with suppuration and great irritation follow, and amputation becomes necessary sooner or later. In one of my cases however, where the os calcis was much broken and comminuted, by keeping the patient at perfect rest for a time, a successful result was obtained without any suppuration occurring.

The ordinary plan of treatment is to keep the foot at a right angle with the leg, and apply a bandage from the foot upwards. Sometimes a pasteboard splint is placed along the sole of the foot. The limb is placed on a pillow, and the leg is very much flexed, so as to prevent the action of the gastrocnemius on the posterior part of the bone. If there be a great tendency for this portion of the bone to be dragged away, I would have little hesitation in dividing the tendo Achilles, as it would unite readily afterwards, and that is the only way to prevent the bone from being drawn backwards ; but I have never met with this difficulty in my own practice.

The bones of the metatarsus are sometimes broken by direct violence, but they do not require any special treatment unless all of them are broken. If only one metatarsal bone is broken the others act as splints, and all the treatment required is to place a pad on the sole of the foot and apply a bandage.

CLINICAL CASES ILLUSTRATIVE OF THE SUBJECT OF FRACTURE AND DISLOCATION.

Case of Un-united Fracture of Humerus, cured by Modified Resection.

History.—On the 11th November 1852, A. Johnston, æt. 22, had his arm caught in a threshing-mill, by which the humerus was broken at two points ; there was one fracture two inches below the surgical neck of the bone, and another at the junction of the middle and inferior thirds of the bone. He was seen by Mr. Falconer of Loanhead, who adjusted the fractures, and put up the limb in pasteboard splints. I saw him in the beginning of February 1853, at the request of Mr. Falconer, as the lower fracture had not united. On examining the arm, I found the upper fracture firmly united ; the lower one, however, was quite movable, but there was no overlapping of the ends of the bone, nor any deformity when the limb hung by the side.

Treatment; Splints.—As the injury was comparatively recent, I advised a further trial of the splints, with pads, so as to keep the parts in accurate contact, the use of nutritious diet, and exercise in the open air. This plan was persisted in till the end of March 1853, when I again examined the arm. There was no attempt at union, and the ends of the bone were felt as if atrophied.

Subcutaneous Puncture.—I tried to excite action by introducing, by subcutaneous puncture, a strong sharp needle, or rather narrow knife, down to and between the ends of the bone, so as to break up the fibrous structure between them, and to scrape their surfaces. The splints were then carefully re-applied, and the arm firmly supported. At the end of six weeks, I found that no change had been produced.

Seton.—In September 1853, I passed a seton between the ends of the bones, and retained it for some days, till suppuration occurred. Even this gave rise to very little local excitement, scarcely any inflammatory swelling supervening. What little there was, passed off very quickly on the seton's being withdrawn, and no benefit resulted from its use.

Resection.—I had previously proposed resection of the ends of the bone, but at the same time thought it right to explain that it was attended with more risk than the methods hitherto adopted, and the young man's friends were at first opposed to its performance. After some months had passed, however, the patient was so anxious to give it a trial, that his friends consented, and I performed the operation in April 1854.

Operation.—I made a longitudinal incision on the outer side of the arm, about three inches in length, its centre corresponding to the seat of fracture. The arm was then bent at the false joint, so as to render prominent the ends of the bone, and the incision was carried down to them. I had determined to separate the bone as little as possible from the surrounding parts, and therefore merely cleared the lower end of the upper

portion sufficiently to enable me to saw through about half its thickness, and I completed the section with a pair of strong bone-pliers. I then did the same to the end of the lower fragment, and snipped off some irregular portions. There was very little bleeding, and no vessel required ligature. The incision was closed with four points of suture, dry lint applied, and the arm placed in a rectangular splint, so adjusted as to allow the wound to be dressed without moving the limb. No constitutional disturbance followed the operation; the pulse never rose above 80. The patient suffered almost no pain, and the wound united entirely by the first intention. Indeed so little swelling or irritation appeared at first, that I was afraid this operation also would fail, but at the end of ten days there was firm limited swelling at the seat of fracture, and the patient stated that he felt the sensation of constant pricking pains in the part.

Result.—At the end of six weeks from the operation, there was hard swelling, involving the ends of the fractured bone, and it seemed firmly consolidated. I therefore sent him home to the country, but directed him to keep on the splints for some time.

I subsequently saw him on several occasions, and I allowed him gradually to use the arm; but in November 1854, I found that from using too much liberty with the arm, it had bent considerably at the united part, showing that it had not quite consolidated. I therefore fractured it fairly across, and re-adjusted it. This was attended with more pain and swelling than had yet occurred after any operation; but in two months afterwards, when I removed the splints, I found firm osseous union, and he can now use the arm with perfect freedom.

Commentary.—In reviewing the case just related, there are two points which, I think, deserve attention; first, the causes which originally prevented osseous union; and second, the plans of treatment adopted.

The causes, generally mentioned as leading to want of union in fractures, are either some state of the constitution debilitating the reparative powers, or some error in the treatment, such as mal-adjustment of the broken bones, too early movement of, or too much interference with, the injured limb. Occasionally, also, the interposition of some portion of muscular tissue between the ends of the fracture prevents firm union.

In this case there was nothing in the treatment which could have led to want of union: the parts had been well adjusted, and accurately retained in position, and there was neither shortening, overlapping of the ends of the bone, nor any other deformity when I first saw him.

As regards constitutional causes, he stated his health to be

good ; but he was rather pale, and suffered occasionally from dyspepsia, apparently depending on an inveterate habit of smoking ; whilst the small amount of local or general excitement caused by any of the operations performed on the arm, would argue a want of energy in the vital powers unfavourable to repair. Still, there was nothing so marked in the state of his general health as sufficiently to account for failure of union, and I think it is to the nature of the local injury in this case that we must look for the explanation.

It will be observed that the humerus was broken across at two points, and that the fracture was the result of direct violence of a kind likely to inflict great injury on the surrounding soft parts. The upper fracture united readily and completely, but the very consolidation at that part would diminish the free circulation through the medullary Haversian structure, and, consequently, impair the vitality of the portion of the shaft between the two fractured points, whilst the bruising of the soft textures would be likely to impede the periosteal supply of nutrition, and thus the lower fracture would be placed in most unfavourable circumstances for union.

Secondly, as regards the treatment, the simpler measures at first adopted proved quite inefficacious, apparently producing scarcely any local excitement whatever. In deciding on resection of the ends of the fractured bone, I determined to remove no more than the rounded and atrophied ends, and to do so with as little disturbance of the parts immediately surrounding the bone as possible. Having often observed, in cases which had come under my notice, in which resection had failed, that fully two inches, or even more, had been removed, it always seemed to me, that not only the amount of bone thus removed, but also the great denudation required to effect its removal, was sufficient to account for the failure, besides increasing the risk of severe constitutional disturbance. Hence I adopted the plan described, by which I was enabled, by using the bone-pliers, to complete the section without insulating the humerus, except the mere portion to be removed ; whilst the bone so divided would more

closely approach to the condition of fracture than if fairly divided by the saw.

The result fully answered my expectations, for there was scarcely a trace of constitutional irritation, whilst the incision healed by the first intention. At the same time, we must bear in mind that the patient seemed peculiarly unexcitable, as shown by the results of the former operation with the needle and seton. The osseous union was felt to be firm, but he had used the arm too soon and too freely, probably before complete ossification had taken place throughout its thickness, and so the bending had occurred. This, however, was scarcely to be regretted, for it led me to fracture it again to obviate deformity, after which the deposit of new bone was much greater than at first after the resection.

Case of Fracture of the Neck of Scapula.

From Hospital Reports.

R. M., a man about forty years of age, applied for advice at the Royal Infirmary on the 17th of January, on account of an injury of the shoulder caused by his falling when in a state of intoxication.

On placing the hand upon the injured shoulder, before removal of his dress, there was no feeling of flattening, but on raising the arm slightly to take off his shirt to examine him more fully, the limb fell towards the axilla, causing a great projection of the acromion and flattening of the deltoid, with all the symptoms of luxation of the humerus downwards in an extreme degree, but attended with the distinct crepitus of fracture. By extending and drawing the arm out from the side and then raising the whole limb, the natural contour of the shoulder was restored, crepitus again being felt as the broken surfaces came into contact. When the support was even slightly removed from the elbow, the limb had the tendency to fall and be again displaced. Under these circumstances, Mr. Spence stated to the students present that the case was undoubtedly an example of that rare form of injury, fracture through the neck of the scapula, the separated glenoid cavity and the humerus being displaced together into the axilla, partly by the weight of the arm, and partly by the great pectoral muscle, together with the latissimus dorsi, and teres major, drawing the arm towards the chest.

A pad was placed in the axilla, and the arm, slung by the elbow, bandaged to the side ; and as the man had also received an injury over the orbit, laying bare the bone, he was strongly advised to remain in hospital. This, however, he refused to do, but promised to return next day. Nothing more was heard of him till the 20th of January, when he returned and

agreed to remain in hospital. During the interval which had elapsed he had been drinking, but the bandages had not been much disturbed. The apparatus was re-adjusted, the patient kept in bed, and warm-water dressing was applied to the wound over the orbit, which had begun to suppurate. Everything seemed to go on well for about ten days; he suffered from no feverishness, and complained of no pain till the evening of the first of February, when he said his eyes felt painful. Warm-water dressing was applied over the eye and the orbital wound, and a purgative was given. Next morning, he suddenly became insensible; the wound looked dry, and its edges were erysipelatous. The erysipelas spread rapidly, and the semi-comatose state changed to violent delirium, under which the patient sank. The cause of death was meningitis, resulting from the injury of the frontal bone; and a suppurative clot was found blocking up the longitudinal sinus. This unfortunate result gave an opportunity of examining and determining the exact nature of the injury of the shoulder. The fracture was found to pass obliquely from below, upwards and forwards, commencing about $\frac{1}{4}$ of an inch behind the origin of the long head of the triceps, and separating the neck and almost the entire glenoid cavity from the scapula. The long head of the biceps and the whole of the glenoid ligament had also been torn from the upper remaining fragment of the glenoid cavity, and carried along with the displaced portion (Plate xv. Fig. 1).

Fracture of the neck of the scapula is admitted by all to be a very rare accident, and by many the possibility of its occurrence has been doubted. Mr. Pirrie mentions three cases where the symptoms were apparently well marked. Sir Astley Cooper also describes a case in which he was consulted; but, on the other hand, Mr. South, in his translation of Chelius's *Surgery*, states that there is no preparation illustrative of such an injury in any museum in London. One dissection of this injury by Duverney is, however, mentioned in Cooper's *Surgical Dictionary*.

The principal value of this case consists in the fact, that, by its fatal issue, a proof of the existence of such a fracture was established, and an opportunity was afforded for examining its exact anatomical nature, and the connection between it and the symptoms observed shortly after the occurrence of the accident. It should be noticed that the fracture did not pass from the scapular notch directly through the neck separating the glenoid cavity and coracoid process from the body of the scapula, as described by Sir A. Cooper, but obliquely through the neck, detaching nearly the entire glenoid cavity, the whole of the

glenoid ligament, and the long tendon of the biceps, so that the articular structures were detached from the scapula, and were readily dragged downwards with the broken fragment by the weight of the limb and the muscular displacing causes.

Fracture of Neck of Humerus with Dislocation of Separated head into Axilla.

Case 1. While Mr. ——, a farmer was riding into town, his horse fell with him, and rolled on him. He recollected that in falling he threw out his arm to break the fall, and that his hand came in contact with the ground. He was brought to the hospital by a medical man shortly after the occurrence of the accident. The appearance of the shoulder left no doubt that dislocation had occurred, but there was also the distinct crepitus of fracture felt and heard on moving the humerus. On feeling for the head of the bone in the axilla it was found lying loose and detached, so that it could be grasped and moved readily, leaving no doubt as to its dislocation from the glenoid cavity and capsular ligament, and its separation by fracture from the shaft. Attempts were made by extension and coaptation to separate the shaft widely from the glenoid cavity, and by manipulation to press back the loose head of the bone into its place, but without success ; and the patient refused to submit to further attempts at the time, and insisted on going home, so that I heard no more of him.

The nature of the accident was very distinct and palpable, and the history of the case shows, I think, very well, how this unusual accident occurs. In falling the man threw out his arm instinctively to break the fall, and alighted with his whole weight upon his hand—the very way in which a dislocation at the shoulder was likely to occur ; and, whilst thus situated, his horse rolled over him, thus causing the fracture of the dislocated bone, for I cannot conceive of any kind of force which could cause luxation of the head and tuberosities of the humerus when broken off from the shaft.

Case 2. J. A. Fracture of the neck of the humerus, and dislocation of the separated head of the bone downwards into the axilla. The patient, who was fifty-three years of age, had, while cleaning a stair, slipped her foot, and, after falling with her whole weight on the right arm, rolled down the stair. She came to the hospital immediately after the accident, and then the right shoulder presented the usual appearances of dislocation downwards into the axilla. On further examination, however, there was found to be a fracture of the neck of the

humerus, and on placing the hand in the axilla, the head of the bone could be felt lying loose, and not moving along with the shaft in rotation. The patient was put under chloroform, and numerous unsuccessful efforts were made at reduction, but it was not until all attempts were about to be given up that the head of the bone was reduced, and then apparently spontaneously. A pad was placed in the axilla, and the ordinary retentive apparatus for fracture of the neck of the humerus applied. She made a good recovery.

As it is scarcely conceivable that both injuries could have occurred at the same time, it is probable that she dislocated her shoulder by the fall, and subsequently fractured the humerus while rolling down the stair.

LECTURE LVIII.

INJURIES AND DISEASES OF MUSCLES AND TENDONS.

Rupture of Muscular Fibre—Causes—Symptoms—Necessity for careful Examination of the Limb—Prognosis—Treatment—Rupture of Muscular Fibre from Direct Injury—Risks—Division or Rupture of Tendons—Symptoms—Treatment—Rupture or Division of Tendo Achilles—Method of Treatment—Deformities resulting from Alteration in Muscles and Tendons—Other Causes in Operation in such Cases of Deformity—Special Deformities and their Treatment—Strabismus or Squint—Wry-Neck—Contracted Tendons of Knee—Treatment.

As wounds of muscles have already been considered in the Lectures on Wounds, I shall now confine my remarks specially to Rupture of Muscular Fibre, and Rupture and Division of Tendons.

Partial rupture of the fibres of a muscle is not an uncommon accident. For example, when a person unaccustomed to much exercise attempts some violent exertion or pedestrian feat, or when a person stumbles and makes a sudden effort to prevent himself from falling, he may rupture muscular fibres. The sensation is as if he had received a blow on the part, say the back of the leg, which is most commonly affected, and he walks lame at the time. After rest the part feels stiff, and the patient is unable to walk without great pain. In some cases we may notice a slight discoloration at the ruptured point, though not generally so, for it is usually the deep-seated fibres of the muscles which give way. Sometimes, however, we find an indentation at the part from the very first. In the latter case symptoms show clearly what has happened, and there is little difficulty in the diagnosis of these injuries, in any case, if we examine the limb.

Where muscular fibre is partially ruptured, especially in the leg, we should examine very carefully the state of the whole limb, because not unfrequently the same symptoms indicate the first stage of popliteal aneurism. Therefore, even when the general symptoms indicate very clearly the true nature of the injury, yet it is absolutely essential to examine very carefully into the state of the whole limb, and not be satisfied with the mere history of the case, or with the account of the patient's feelings. If, on examination, we find it to be a case of rupture of muscular fibre, the treatment, to be successful, requires to be very careful at first. The prognosis is, that the patient will not walk well for some time, and that the limb will probably be stiff and lame for a year after the accident, but that he will ultimately gain perfect use of the limb.

The best treatment at first is to keep the patient absolutely quiet, with the limb flexed, so as to relax the muscular fibres and allow them to heal by as short a uniting medium as possible, and so have the efficiency of the muscle fully restored. The shorter the uniting medium is, the better. Whether in muscle or in tendon, this is uniformly formed of fibrous, never of muscular texture. It is like a central tendon, and forms the line of connection in what has become a sort of digastric muscle. If this fibrous texture be short, then the muscular fibres attached to it on either side will act as well as before, but if we allow a long soft uniting medium to form a large gap between the muscular fibres, we obtain a large central tendon, and the efficiency of the muscle is thereby impaired to a corresponding extent. Hence the necessity for keeping the limb at rest and the muscle relaxed in the first instance. Tepid opiate or anodyne fomentations, followed by evaporating lotions, should be applied to the part to allay the pain, and to get rid of any effused blood. If there be great effusion of blood in the neighbourhood at the time, we should be very cautious about interfering with it by making incisions, even though there be fluctuation, because there is a risk of mistaking the fluidity of the effused blood for the fluctuation of suppuration. If we make in-

cisions into the effused blood, we are very likely to set up an unhealthy form of suppuration, while, by leaving it alone, it will disappear of itself, and therefore we should never interfere unless when matter has begun to form.

Rupture of muscular fibre may occur from direct injury of the muscle, but here we must remember that other textures may also be affected from the nature and degree of the force. Gangrene may even result, in some cases, from extensive rupture of muscular fibre, even though the skin shows no symptom of injury, for the vessels lying in the neighbourhood of the muscle may be destroyed. A boy, lately under my care in the hospital, was struck by a planing-machine on the thigh, over Hunter's canal. There was an indentation containing fluid over the part, and there the femoral artery could be readily felt pulsating. The fibres of the sartorius were ruptured and retracted, the vessel was thus so far uncovered, that the feeling of pulsation was very distinct. At first I was afraid that the vessel was injured, but, on examining it with the stethoscope, I found that the current of blood was quite natural; the extravasated blood must have been from small vessels. The case went on well, and the muscle united again by a shorter uniting medium than we can generally expect in the case of the sartorius muscle.

Division or Rupture of Tendons may occur in various ways. They may be wounded in any direction. Not unfrequently we find the whole flexor tendons of the wrist divided by machinery, or by a knife, and the extensors on the back of the hand also injured.

The treatment of such cases is just that of a simple wound, but we must take care to keep the limb in such a position that the ends of the tendons may be as near together as possible, so as to get a short uniting medium. I have seen the whole of the flexor tendons at the wrist divided, and the lower end of the radius fairly cut through, yet the parts united, and a very useful hand was left. At the ankle I have also seen the extensor muscles and anterior tibial artery divided, and the tibia cut obliquely into the joint by a reaping-machine.

The patient, an elderly woman, made a good recovery under the ice treatment.

Injury of the Tendo Achilles is a common accident. It may occur from a cut, or the tendon may be ruptured by violent exercise. Not unfrequently it happens when a stout elderly gentleman indulges in dancing. There can be no difficulty in the diagnosis of the case if complete rupture has taken place. The patient falls suddenly to the ground, and we find the gap between the two ends of the tendon very apparent.

The treatment of the case is simple. A great deal of attention has been bestowed on this particular accident, though there is nothing very peculiar in it. The second Monro met with this injury. He very naturally paid special attention to the treatment of his own case, and afterwards published a memoir on the subject, which drew attention to the injury. In treating rupture of the tendo Achilles, the leg should be bent as much as possible, and a well-fitting sock or slipper placed on the foot. To the sole of the slipper we fix a piece of tape, which is brought up and buckled to a ring of bandage placed round the thigh, so as to flex the limb and relax the tendon, very much in the same way as in the treatment of popliteal aneurism by flexion (Plate xx. Fig. 3). We should also at first apply a roller to prevent retraction of the gastrocnemius, and two lateral pads, so as to compress the tendon slightly on each side and prevent it from moving about, which it is otherwise apt to do. After five or six weeks, but not sooner, we may begin to relax the limb gradually. The patient must not be allowed to use the limb even then, because the uniting medium being still soft, if the foot were used it would be lengthened, and a good cure might thus be spoiled. We must wait till the uniting medium has acquired such a degree of firmness and solidity that it will not be likely to become stretched by use.

In some cases the tendon may not be completely ruptured at first, and the patient, though lame, may consider it a simple sprain, and walk about, and then some false step may complete the rupture.

Under these circumstances the injury is apt to be neglected, and when a medical man is called in he finds that the tendon has so far healed by a very long and soft uniting medium, and the heel droops unsupported. Under these circumstances the treatment is to maintain the part at rest for a time in the position already indicated, and then to give support to the limb by proper apparatus. The simplest and best is an elastic and laced stocking, with a strong leather support in the position of the ruptured tendon, the leather gradually becoming thinner above and below, and extending from under the heel to the upper part of the calf of the leg. This support enables the patient to walk comfortably, and favours consolidation and contraction of the new uniting structure. When the tendo Achilles has been cut through, after closing the wound we treat the limb as in the former case, or we may pass a stitch or two of silver wire through the skin and the ends of the tendon, so as to keep them accurately in position. If the stitch cause any irritation it must be taken out. The rest of the wound is brought together by the ordinary suture.

The Deformities resulting from Morbid Contraction of Muscles and Tendons are either congenital or accidental—most generally the former, for injuries of tendons seldom cause permanent contraction if they be properly treated. The various forms of club-foot, and some forms of wry-neck and strabismus, are examples of deformity due to the permanent morbid contraction of muscular fibres.

The subject of deformity, arising from contraction of muscles, has always attracted considerable attention, and more especially in recent times since the treatment by subcutaneous section was introduced; so much so, that it now forms a sort of specialism or subdivision of surgery—Orthopedic Surgery. Whilst I admit that the attention given to this department by gentlemen who have devoted themselves specially to the treatment of such deformities, has done much to improve our methods of treatment, I yet doubt whether the benefit derived from such specialisms is not more than counterbalanced by the tendency to make too much of the

subject. Leading to the invention of highly ingenious but useless machines for rectifying deformities, to the exclusion of simple and more efficacious apparatus, and to promising too much in cases where little good can be expected, and where the apparatus often does harm. I fear, also, that they often lead to the proposal of operations or the application of apparatus where no such measures are required.

In this course of lectures I shall confine myself to the consideration of those deformities which most frequently present themselves to the surgeon for treatment.

Before proceeding to speak of these special deformities, I would caution you that, whilst in general terms we speak of them as being due to contraction of muscles, you must always recollect that changes in other textures—such as shortening and thickening of ligaments, alterations in the forms of bones, and of their articular facets, and contractions of fasciæ and aponeuroses—are also very generally present, and require consideration in the operation and after-treatment of such cases. In some cases the cause of deformity is not so much morbid contraction or shortening of one set of muscles, as loss of power from paralysis in the opposing muscles. In other cases the muscular system may not be at fault at all. Thus, in some forms of wry-neck, the deformity results entirely from chronic disease of the ligamentous and osseous textures. And in many cases of strabismus the squint is not permanent, but evidently dependent on some nervous affection, or on some condition of the eye. Hence you will perceive the necessity of carefully examining cases before proposing operations or other treatment for their relief.

I shall now proceed to the subject of SPECIAL DEFORMITIES AND THEIR TREATMENT, commencing with strabismus or squint.

There are two forms of SQUINT, the converging and diverging. In the former the eye is directed or drawn in towards the inner canthus. In the latter the eye is turned outwards. In either case the squint may be modified by more or less obliquity, and this is specially noticeable in the converging

squint, in which the eye is very generally directed upwards and inwards. The remote causes of strabismus are very various. The debility of vision, or of the muscles of the eyeball, resulting from infantile diseases, strumous inflammation, specks on the cornea, direct or indirect irritation of the brain and nervous system, may each and all give rise to squinting. In many cases we find that squint is not persistent, but is excited at times by mental emotions or disorders of the digestive organs.

When we examine into the state of the eye and its muscles in cases of persistent strabismus, to ascertain the proximate cause with a view to treatment, we meet with some in which, owing either to morbid shortening of one muscle or paralysis of its opponent, the eye is immovably fixed in the abnormal position, but these cases are comparatively rare. Most generally we find that when the sound eye is closed and covered, the strabismus disappears, the affected eye becoming straight. If we suddenly open the eye, which is usually straight, we will notice that it has been squinting whilst the other was straight. In many cases we have alternating strabismus, the squint being sometimes in one eye, sometimes in the opposite, or we may have double converging strabismus.

In regard to the treatment of squint, it is evident that must depend on the cause. In many cases operative measures are contra-indicated—as, for example, in those where we have a peculiar rolling, restless motion of the eyeballs, and other symptoms of nervous excitability, or in those where the squint is not persistent. In many cases also, by general treatment, and closing the sound eye, thus forcing the patient to use the affected one, the parallelism of the eyes is restored. But in other cases, if, after adopting this treatment, we find it ineffectual, and when we have reason to believe that the proximate cause is either morbid contraction of one muscle or paralysis of its opponent, then we may bring the parts into more natural condition by division of the faulty muscle. This constitutes what is termed the operation for strabismus. The muscles which require to be divided are, the internal rectus in

cases of convergent squint, and the external rectus in the divergent form. Besides thorough division of the muscle, it will often be found that division of thickened bands of sub-conjunctival tissue requires to be made to free the eye, especially when the convergent squint is persistent and of long standing.

The operation is very simple and efficacious if properly performed. The only instruments required are a pair of finely-toothed, rather broad-pointed forceps, to raise the conjunctiva for division; a small blunt or probe-pointed hook of steel or german-silver, to slide under and raise the muscle; and a pair of ordinary straight scissors, blunted at the points. I used formerly to employ a very small sharp hook to fix the eye and draw it outwards; but it is really not necessary, and is liable to lacerate the conjunctiva. Suppose a case of convergent strabismus is to be operated on. The eyelids having been separated and held by an assistant, whilst the opposite eye is closed, the operator desires the patient to look outwards, or if chloroform be used, the eye is drawn outwards by the forceps, and then the surgeon, raising a fold of the conjunctiva, makes an incision through it with his scissors about midway between the corneal margin and the inner canthus. In most cases, if his incision has been complete, the blunt hook can be readily passed back and beneath the internal rectus, so as to enable the surgeon to draw it forwards and divide it with the scissors. The muscle should be distinctly seen, and the surgeon should make sure that the whole is on the hook, for the muscle is broad, flat, and closely applied on the sclerotic, and a thin flat hook may perforate it and leave some fibres unraised. For this reason I prefer the probe-pointed steel hook of Græfe, as being less liable to injure either the muscle or the sclerotic coat of the eye. When the muscle is fairly cut, the patient is unable to invert the eye to any great extent. If any power of inversion remains, it is necessary to examine, lest fibres either of muscle or thickened sub-conjunctival tissue still require to be divided. Afterwards the conjunctiva is smoothed down, the

eyelid closed, and a pledget of lint dipped in cold water is applied over the eye for some hours. Little or no after-treatment is necessary, unless any unwonted symptoms supervene.

In divergent squint the muscle to be divided lies in close relation to the ocular insertion of the inferior oblique, in fact overlaps it, and also the long branch of the third pair of nerves supplying that muscle, so that more care is required in drawing forward the external rectus for division, to make sure of isolating it from the other structures. With the exception that the conjunctiva is divided between the corneal margin and outer angle of the eye, the steps of the operation are the same in both cases. When the operation for strabismus was first introduced here, I operated in a very large number of cases. Out of sixty cases on which I had operated from 1838 to 1843, I had only met with two cases of divergent strabismus, and in both of these the operation was perfectly successful. In some cases of convergent squint I have found it necessary to divide the internal recti of both eyes to secure a successful result.

In the operation, as originally performed, the incision of the conjunctiva was made in a vertical direction ; but now I almost invariably use a horizontal incision, as the eye appears more natural afterwards, and the cicatrix is less. In divergent squint, however, I would still recommend the vertical incision, as giving more room, and enabling us to see the parts we are about to divide.

The cases of Wry-Neck in which the surgeon can relieve the deformity by myotomy are not very numerous. In the great majority the distortion arises from gradual chronic changes in the ligamentous, deep-seated muscular, and sometimes in the osseous texture of the vertebræ. In these cases operations would be useless or hurtful. In some cases, however, the deformity evidently depends on shortening or contraction of the sterno-mastoid muscle ; and in them we can relieve the distortion by division of the muscle, or the part of it which is faulty. This condition is not always a congenital deformity, but may arise

from long-continued irritation, or chronic inflammation of the muscle and its fascial sheath; and I have operated successfully in adults well advanced in life.

The part of the sterno-mastoid which most usually requires division is the sternal attachment or inner head of the muscle. When the contraction is present, this portion seems narrowed, distinct, and prominent, so that you might suppose that a touch of the tenotomy-knife would sever it at once. In reality, however, there is greater breadth and thickness of muscular and tendinous texture than the appearance of the contraction would lead you to expect, and it is well to be prepared for this, for the part of the muscle to be divided lies in the neighbourhood of important structures. Large veins passing down to join the internal jugular lie close behind, and the great jugular itself is not far removed, so that it is important that, if possible, the whole resisting tissues be divided without having to re-enter the sharp-pointed knife after partial division. Indeed, when any resistent structure remains deep seated, it is better to use a fine probe-pointed knife, introduced through the original wound. In some cases the contraction involves the fascial textures, which become thickened to a considerable depth. In operating in cases of this kind I have considered it safest to do so by exposing the parts to be divided by free incision instead of the subcutaneous method.

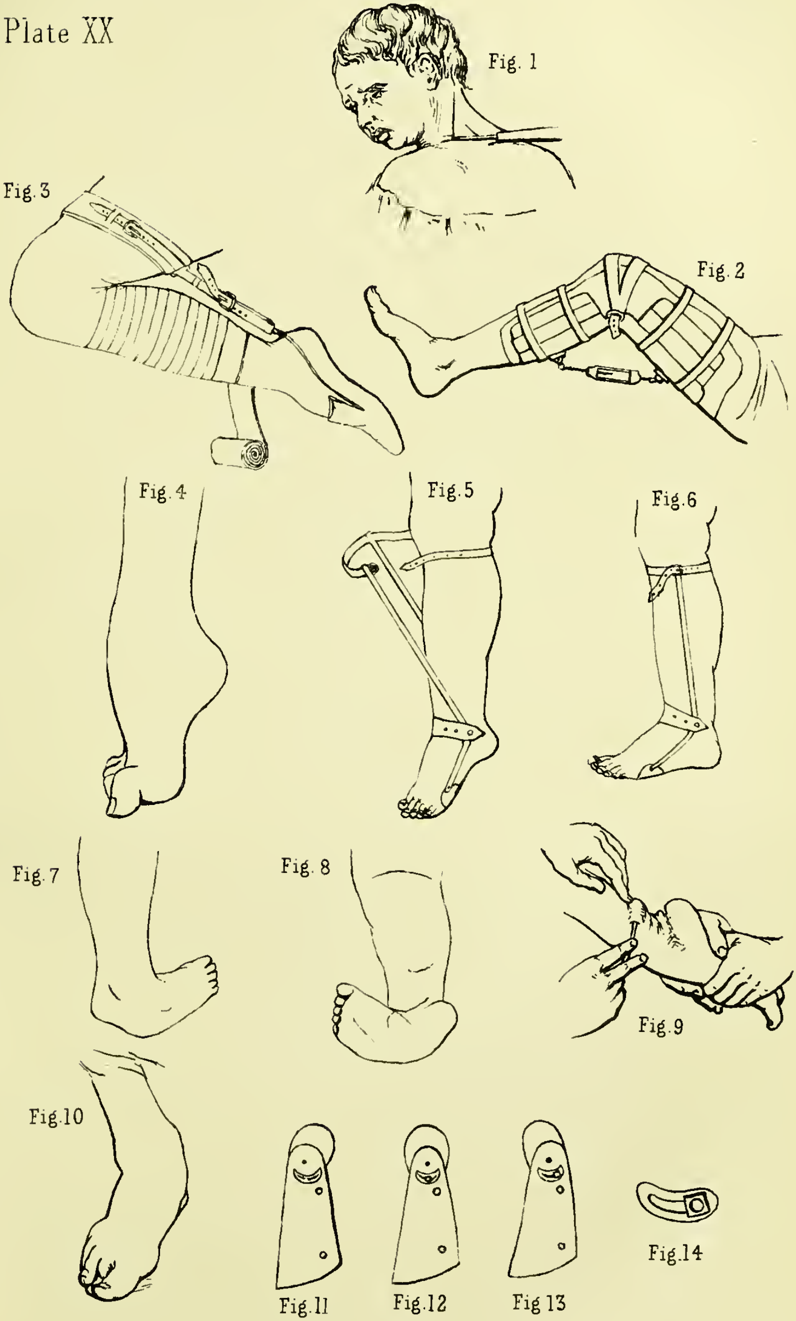
In performing the operation under ordinary circumstances, the head is placed so as to put the contracted portion of the sterno-mastoid on the stretch. The surgeon pinches up a fold of skin over the contracted muscle near its sternal origin, enters the tenotomy-knife, and glides its blade between the skin and muscle till it is fairly beyond the free edge of the sternal attachment. Then, turning the cutting edge towards the muscle, he divides it whilst an assistant keeps the head back (Plate xx. Fig. 1). When the contraction is fairly divided, a little pad of lint is placed over the part, and the position of the head maintained by means of a circlet of bandage round it, from which lateral bands pass to another circular bandage round the upper part of the chest,

so as to enable the surgeon to keep the head back, and the face towards the side opposite to which it formerly looked. This is done by gradually tightening the lateral straps or bandages, so as to give the necessary inclination. In some cases both sterno-mastoids are contracted, and the head bent forward. In such cases both require to be divided; but in many of these, some of the other structural alterations alluded to are present, as well as contraction of the muscles, and then the operation does not much improve matters.

Division of CONTRACTED TENDONS AT THE KNEE-JOINT is generally had recourse to as an accessory to other operations for contracted knee, such as the breaking up of anchylosis, or the excision of the knee where there is great contraction, to enable us to place the parts in good position. When required, the subcutaneous division of the tendons should always be the preliminary step in the operation, as their section is then more easily and surely accomplished. In dividing the outer hamstring muscle, the biceps, it should be divided near its fibular insertion, where it is narrowest; and in doing this, care must be taken to avoid the peroneal division of the great sciatic nerve, which lies in close proximity. The mode of introducing the tenotome, and stretching the tendons to be divided, is similar to that advised in section of the sterno-mastoid. After division of these tendons, in cases of contracted knee-joint, the joint is gradually straightened by the screw-lever splint represented in Plate xx. Fig. 2.

INJURIES & DISEASES OF MUSCLES & TENDONS.

Plate XX



Waterston & Son Edinr. Lith.

LECTURE LIX.

Club-Foot—Classification of the different Forms—Former Methods of Treatment—Subcutaneous Tenotomy—Necessity for After-Treatment by Apparatus—Talipes Equinus—Talipes Calcaneus—Talipes Varus and Talipes Valgus—Causes of Deformity and Treatment of each.

THE various forms of CLUB-FOOT constitute the largest and most successful field for the practice of orthopedic surgery. In a course of lectures such as this I cannot enter into all the plans of treatment adopted; but will state as succinctly as possible the nature of the deformity, the general principles to be attended to in regard to treatment, and describe the methods of operating I have found most simple and efficient in my own practice.

Club-foot is usually classified under four primary forms:—1. Talipes Equinus; 2. Talipes Calcaneus; 3. Talipes Varus; and 4. Talipes Valgus. Other varieties depending on the combination of the features of the primary forms, such as Talipes Equino-Varus, are mentioned, but in most cases of talipes varus the heel is drawn upwards as well as inwards.

The different varieties of club-foot used to be treated principally by various forms of mechanical apparatus, such as boots of different shapes. In some cases tenotomy was performed by cutting through the skin as well as the tendons. Subcutaneous tenotomy was introduced comparatively recently. This is a most important operation, for we can by it remove many kinds of deformity; we should not, however, trust entirely to the division of the tendons, which is merely a means to an end. There is, generally, some altered condition of the articulations and bones, as well as of the tendons, which requires to be remedied; and properly applied mechanical apparatus is therefore necessary, if we wish for a complete cure. In a case of talipes varus, for example, when we divide the tendons in fault, we can bring the

foot very nearly to its natural position at the time, without using any great force, but if we merely put the foot in a strong leather boot, and send the child away, telling its parents that nothing more is required, then probably the foot will be as bad as ever in a very short time. We must use means to keep the foot in the proper position, and keep the divided tendons far apart during the healing process, so as to get a *long* uniting medium. The contracted ligaments must be stretched, but this must be done gradually. If done at once, we expose the thin skin to a great deal of traction, which might probably cause it to ulcerate. We at first bandage, without stretching the parts very much for a day or two, then put up the foot in a splint to keep it in its natural position, and afterwards apply a form of apparatus, the foot-piece of which is movable transversely, and which also keeps down the heel. In this way a permanent cure may be effected. In some cases the club-foot is partly due to inversion of the whole limb, and then there is no use in dividing too many tendons; the eversion must be effected by other apparatus. Children are often brought to hospital for the cure of club-foot when only a few weeks old. It is, however, better not to operate so soon, for the bandages round the foot are constantly kept wet by the child's urine, notwithstanding the use of oil-silk or other protective measures, and the sore becomes irritable from this cause. Hence, though there is no risk in operating on very young children, I think it is better to delay doing so till the child is somewhat older.

Talipes Equinus (Plate xx. Fig. 4) is a form of club-foot where there is pointing of the foot arising from contraction of the gastrocnemius, soleus, and tendo Achilles. In a great many cases of simple talipes equinus, we find that the muscles of the anterior part of the limb are paralysed. The condition has arisen in childhood, either after infantile diseases, or from what is termed infantile paralysis. The anterior set of muscles having lost their power, there is nothing to counterbalance the action of the muscles of the calf, which then draw up the heel, and become increased in power as it were, the anterior muscles remaining

almost unused. In such a case we must remember that if the anterior muscles be permanently paralysed, division of the tendo Achilles, though it will let down the heel and do good so far, yet will not be productive of much benefit as regards the use of the limb. On the other hand, if the anterior muscles have been only temporarily paralysed, by exercising these muscles, we may make them come into action again, and so counterbalance the effect of the gastrocnemius and soleus, and then division of the tendo Achilles will be of permanent benefit. We should remember, in regard to the former class of cases, that we have a certain power of increasing muscular development, and also that muscular development does not depend altogether on nervous energy, for we can divide the nerve of supply to a muscle, and yet keep up its development to a great extent by means of galvanism. It is true that if the normal nervous energy be destroyed, we cannot go on long keeping up the development of the muscle, but by using electro-galvanism along the course of a muscle, we can do a great deal to restore its power. In many cases the nervous power has not been entirely lost, but has been in abeyance as it were, and we can then restore it. Hence, in talipes equinus, along with division of the tendon, we should employ such means as galvanism, friction, and the tepid or cold douche, to restore the muscular power of the limb in front, and so equalise the muscular forces on the anterior and posterior aspects of the leg.

The operation for division of the tendo Achilles in talipes equinus is a very simple one.

An assistant holds the foot so as to press the heel upwards, and relax the tendon and the skin over it (Plate xx. Fig. 9). The surgeon then pinches up a fold of skin over the tendon, glides the tenotome between the skin and tendon with the blade in a flat position, then turning the cutting edge towards the tendon, he desires the assistant to draw down the heel so as to render the tendon tense, and presses his knife against the resisting structure till he feels it snap and its ends retract. Should any fibres, however few, have escaped division, their section

must be accomplished to render the operation completely effectual. Various forms of apparatus are used for gradually bringing the foot into its proper position, and maintaining it there; but the most efficient of these is the one represented in Plate xx. Figs. 5 and 6. The mode of action is obvious.

Talipes Calcaneus is an exceedingly rare deformity as a congenital condition. I have seen several cases arising from contraction after burns on the front of the leg and ankle, but I have never, in my own practice, met with it as a congenital deformity. This malformation consists in the foot being bent forwards at the ankle, and the heel pointed downwards and backwards with a slight inversion of the foot. The tendons which seem to be in fault are chiefly the extensor of the great toe and the tibialis anticus, sometimes the common extensor of the toes. In many cases it will be found that there is either alteration in the gastrocnemius and soleus, or their common tendon, the tendo Achilles, which has permitted the extensors to give rise to the malposition of the foot.

The treatment consists in subcutaneous section of the tibialis anticus, the extensor of the great toe, and if necessary some of the contracted tendons of the common extensor. Then the foot is drawn back and the heel raised by using at first the simple apparatus recommended for divided or ruptured tendo Achilles, and subsequently using a special apparatus to prevent the tendons from uniting too soon or by too short a medium.

Talipes Varus is by far the most common form of club-foot. The foot is turned inwards, and the heel more or less elevated; the sole looking inwards and somewhat upwards, giving the whole foot a peculiar twisted appearance. (See Figs. 7 and 8, Plate xx.) In general the foot is shortened or bent upon itself owing to contraction of the plantar fascia. In cases where the deformity has existed for some time, and where the patient has walked, there is generally a large adventitious bursal formation on the outside to obviate the bad effects of pressure on the prominent part which rests on the ground. When you look attentively at a foot affected with talipes varus, you will observe that

the principal deviation from the natural position is the turning in of the anterior part of the foot at the line of articulation of the os calcis with the cuboid, and of the astragalus with the scaphoid, that is just in front of the ankle. The os calcis is drawn up to a certain extent, but not much if at all inverted. When the heel is very much drawn up the deformity is sometimes termed talipes equino-varus. The ligamentous textures on the outside are stretched and more expanded than natural, whilst those on the internal aspect are shortened and thickened. In old cases these changes in the ligaments are very marked, and the forms of the tarsal bones are altered. Even in infants some slight deviations from the normal form of the bones exist, but not of a kind to give rise to any practical difficulties in the treatment. In the plantar fascia the most marked alteration is the contraction and thickening of the internal division of that structure. In its natural condition the internal portion of the fascia is thin and weak, as compared with the strong central portion; but in varus it is often almost, if not altogether, as resistent as the middle portion. The latter also is contracted so as to shorten the foot and arch the instep. The morbidly contracted muscles, which maintain the parts in this abnormal position, are the anterior and posterior tibial muscles; the gastrocnemius, soleus, and plantaris gracilis.

Division of the tendons of these muscles, together with the contracted resistent portions of the plantar aponeurosis, constitutes the operation for talipes varus, enabling us to apply an apparatus effectually. In regard to this operation, the surgeon must keep in view not merely the anatomy of the parts in their natural condition, but in the abnormal state in which he requires to operate. The alteration chiefly affects the position of the tendons. The bloodvessels are very slightly if at all displaced. The posterior tibial is somewhat relaxed from the altered position of the foot, and seems to curve slightly forwards above the inner ankle, and the great saphena vein is also occasionally somewhat displaced; but the surgeon can and ought always to ascertain the position of this latter vessel before operating. In regard to the tendons, the relations of the tibialis anticus

are hardly altered, except that it is shortened and more tense than usual. The tendon of the tibialis posticus, on the contrary, is exceedingly altered in course and relation, owing to the altered position of the tarsus. This tendon, in a well-marked case of varus, passes almost straight, or with a very slight obliquity, down to its insertion at the internal cuneiform and base of the metatarsal bone of the great toe, instead of curving round below the internal malleolus, and then passing forwards as in the natural foot. A want of consideration of this altered state of parts has led to the proposal to divide the horizontal portion of the tendon in the foot as it passes forwards, so as to avoid risk to the tendon of the common flexor and the posterior tibial artery, instead of the usual plan of dividing it behind the lower part of the tibia. The tendon in varus, however, does not pass forwards, but almost directly downwards to reach its insertion, and hence the proposal is nugatory. The tendo Achilles, and the tendon of the plantaris gracilis, are shortened and distorted, so that they are not so well marked as usual, and the fascial textures around are thickened and often adherent to the tendon, so as to require division before the heel can be brought down.

Keeping in view these alterations in position and structure, it will be obvious, that though the operation is in itself a simple one, it requires care and precision in its performance, so as to relieve the contracted parts, and care and observation in arranging and managing the mechanical apparatus subsequently to complete the cure by proper after-treatment.

As to the mode of performing the operation.—It is generally laid down as a rule, that the tendons of the tibialis anticus and posticus should be first divided before dividing the tendo Achilles. I can see no very good reason for this, because, when the tendo Achilles is divided, and the heel fairly brought down, we can, I think, judge better as to the division of the other tendons having been thoroughly effected, otherwise we may attribute any difficulty of everting the foot as partly due to the contracted tendo Achilles. In my own practice I have always divided the tendo Achilles as the first step of the operation, and I have never

found any difficulty or bad consequences result from this. The division of the tendo Achilles is effected thus :—The assistant extends the foot so as to bend the heel towards the back part of the leg. The skin over the tendon being thus relaxed, the operator pinches up a fold of it immediately over the lower part of the tendon, glides his tenotome between the skin and tendon, then turns the cutting edge towards the tendon, and desires the assistant to stretch the heel. He then presses his knife till the section is completed, which is easily recognised by the sudden snap and the laxity of the heel (Plate xx. Fig. 9). In dividing the two tibial muscles, we cannot easily pinch up the skin, and therefore put the foot on the stretch by trying to evert it. The tibialis anticus is thus made tense. The surgeon enters the tenotome over the inner side of the tendon, carefully avoiding the saphena vein, then passes the knife over the tendon, and cuts firmly upon it till he feels it separate. In dividing the tendon of the tibialis posticus, I feel for the internal edge of the tibia, immediately above the malleolus, and holding the tenotome flat, and its edge directed downwards, I pass it in till I feel it project over the edge of the tibia, and then press it across the course of the tendon, altering the position of the blade, so that the edge is turned towards the tendon and tibia, and the back towards the posterior tibial vessels. I then carry it, with a decided stroke, towards the bone, whilst the foot is everted, and in this way the tendon is thoroughly divided. I have already stated the reason why we cannot, in cases of varus, divide this tendon in the foot, as was once proposed. In every case the internal, and at least the inner part of the middle portion of the plantar fascia must be divided.

Having divided the tendons and fascia, and applied pads of lint and bandage, I seldom use any apparatus to stretch the foot for the first two days, or at most only a leather or gutta-percha splint. The second day after the operation I apply a strong leather splint, formed into a leg-piece and straight sole, and thus bring and maintain the foot more in its natural position, without overstretching the thin skin over the divided tendons. In two

or three days after this I begin the use of the special apparatus, and that which I prefer is Stromeyer's, modified to suit particular cases. There is, however, one part of the apparatus which I consider of essential importance, and that is the formation of the sole of the foot-piece. This is very generally made of a single piece, so that whether we act on the foot by side-spring, screw-lever, or straps, the whole foot, including the heel, is acted on. Now, if we remember that the inversion is at the transverse articulation, between the os calcis and astragalus, with the cuboid and scaphoid bones, it is evident that we can correct the deformity most efficiently by keeping the heel fixed in a straight position, and then everting the anterior part of the foot. For this reason the sole of the boot, or apparatus, ought always to be composed of two separate portions, as represented in Figs. 11 to 14, Plate xx. so as to allow us to act directly on the deformity. In other respects we require to watch each case, and modify our apparatus according to circumstances. I have frequently tried straps of vulcanised india-rubber instead of leather, but I confess I begin to suspect there is a fallacy in trusting to such elastic material ; we can scarcely regulate them so well as less yielding straps.

Talipes Valgus is another form of club-foot. In it there is eversion of the foot. The foot is turned upwards and outwards, very much as it is in Pott's fracture ; owing to the contraction of the peronei muscles (Plate xx. Fig. 10). The talipes valgus is, however, not nearly so common as the talipes varus, nor is it met with so often as a persistent condition, though it is not unfrequently met with in young girls as a hysterical condition. In such cases, by general constitutional treatment, and by rubbing the limb for a time with the hand, and moving the foot inwards, we find that the foot can gradually be replaced without any force. We rarely require to divide the tendons in talipes valgus unless it be a persistent condition, and then the peronei are the muscles in fault, and the section of their tendons is very readily effected where they pass behind the malleolus externus.

LECTURE LX.

INJURIES AND DISEASES OF THE BLOODVESSELS.

Anatomical and Physiological Peculiarities of Bloodvessels—Veins—Wounds of Veins—Thrombus—Mode of healing in Wounded Veins, and re-establishment of Circulation through them—Treatment of Venous Hæmorrhage—Diseases of Veins—Phlebitis—Symptoms which characterise the Acute Form—Pathological condition—Subacute or Fibrinous Phlebitis—Symptoms and Localisation—Risk of its becoming Diffuse—Abscess—Thrombus—Treatment of the different forms of Phlebitis.

The peculiar anatomical characteristics of the veins and arteries must be considered in reference to wounds and diseases of these vessels, so that we may understand how their diseases arise, and what are the principles of the treatment to be adopted.

The coats of the veins differ from those of the arteries in two respects, first, in the want of the middle fibrous or muscular coat, which gives to the artery its roundness, contractility, and firmness, and to a certain extent its propelling power. Secondly, in the valvular arrangement of their lining membrane. The veins, however, have, like the arteries, a firm fibro-cellular external coat, and also a lining membrane, with intermediate connective areolar texture. In certain diseases we find that the areolar texture between the lining membrance and the external coat becomes very much thickened by effusion of plastic lymph, so that the venous coats, which are naturally very thin, become much firmer. A vein has not the uniform roundness of an artery, but is irregularly distensible, and on injecting it we notice irregular sac-like dilatations, caused by this unequal distension, and at certain parts are little nodulated points marking the position of the valves.

An artery has for its function the propulsion of the blood

through the body, regularly and continuously, and so the interior of the vessel is smooth, and its canal uninterrupted by any inequalities, and even when any obstruction does occur, the collateral branches carry on the circulation. In the case of the veins it is different. There are a variety of hindrances to the return of the venous blood; we find that owing to different states of the viscera or muscles, the free return of the blood is interfered with. Hence the veins require to have a power of distension, or of forming reservoirs for the accumulation of venous blood under certain circumstances. We find the sinus-like dilatation of veins allowed by a peculiar condition of their coats, and this condition has a great bearing upon the wounds of veins and the way in which they heal. Valves to support the returning column of blood are found in nearly all the systemic veins, but in the lower extremity they are much more marked than elsewhere, for there they are most required. In the portal system of veins and in the hæmorrhoidal veins there are no valves; but even in the veins of the neck, where, owing to the direction of the blood-current, there is but little tendency to obstruction of the venous circulation, there are valves at different intervals, though there they are fewer and less marked than in the veins of the arm and leg—in which the returning column of blood requires mechanical support.

It is also necessary to trace the arrangement of the lining membrane with regard to the valves, in order to understand some of the diseases of veins. The lining membrane in veins is analogous to the same structure in the arteries—it is perfectly smooth, and lines the whole interior of the vessel. When we trace it to a valve, we find no implantation of a structure like a valve upon the lining membrane, but the latter seems to project and form a duplicature, so as to make a valve. These valves are more or less complete. They project towards the centre of the vein, and when the column of blood has passed beyond them they are thrown back so as to close and support it. In the normal condition it is evident that the efficiency of these valves is important. Their competency will depend on the state of the lining membrane of

the vein, and also upon any distension of the vessel; for the distension of the vein acts in two ways. A valve, which, in the normal condition is sufficient to close the vein, would become insufficient if the vein were distended, even if it were a valve implanted on the lining membrane. When, however, the vein is enlarged in calibre the lining membrane is drawn upon by the distension, and the valves formed by its projections are therefore diminished in size.

Keeping these facts in view, we shall now consider WOUNDS OF VEINS.—When a vein is wounded, the blood flows from it in an even stream, without any jerking or saltatory movement. The blood is of a dark colour, and the bleeding is generally easily arrested by pressure on the opening, or beyond it, on the distal side of the wound, or by the removal of any barrier to the venous circulation which may exist between the wounded point and the heart. Thus, in bleeding from the veins at the bend of the arm, all that is required to stop the bleeding is to remove the fillet round the upper arm and apply a compress and bandage. If a vein be opened by an indirect wound under the skin, it gives rise to effusion of blood into the loose cellular tissue around it, forming a tumour of greater or less size, called a *thrombus*, which is nothing more than a clot of blood. Such a tumour should never occur during or after venesection, for we should always choose a vein which is fixed, and the external opening in the skin should be sufficiently large to allow of the free escape of the blood. In cases of accident, however, or when a vein has been badly opened in bleeding, a thrombus may occur. Even if it does, no bad consequences will follow. If we close the opening in the vein, apply cold and evaporating lotions over the tumour, and keep the part quiet, the thrombus will gradually disappear. In opening a vein in the arm, a thrombus may be formed, and if placed over the brachial artery it has been said that it might be mistaken for an aneurism of that vessel, and so might lead to a serious mistake. But this is not very likely to happen.

There is one peculiarity of wounds of veins which I have frequently verified in experiments on animals—namely, that they heal principally from without. If we look at a vein which has been fairly cut across and tied, or which has been compressed, we find that it is pervious close down to the point where it was divided. Around the vein at the wounded point there is a quantity of lymph effused externally, but there is little or no tendency to change in the interior lining membrane. In a wounded artery we always find complete obliteration of the vessel at the injured point. The blood never circulates again through that part of an artery which has been wounded, whilst if a vein has been merely wounded, and not fairly divided, the circulation goes on through it as before. The small opening made, closes externally by effusion of lymph, while the interior of the vein remains in its natural condition; so that in former days, when venesection was more common than it is now, a patient used to be bled several times from the same vein. This peculiarity arises in great measure from the sac-like distensibility of the vein, which allows it to be kept flaccid for a time, and afterwards allows the circulation to go on as perfectly as before. It is important to keep this in mind in reference to the radical cure of varix, for we may partly obliterate a vein, and yet the circulation may be re-established through it. In all cases of wounded veins there are two things to be done—first, to close the external opening by compress and bandage; and second, to favour the circulation returning towards the heart by attention to position of the part, and by removing all articles of dress which might constrict the limb above the wound or ulcerated opening in the vein. If we leave any obstruction between the opening and the heart, hæmorrhage may recur from time to time and exhaust the patient.

The first of the DISEASES OF VEINS which we have to consider is PHLEBITIS, or INFLAMMATION OF VEINS. This is either *acute* and *diffuse*, or *subacute*, *circumscribed*, and *fibrinous*.

ACUTE PHLEBITIS may arise in various ways from irritation of a wounded vein, as from punctured wounds in their vicinity, or

from the application of a ligature to a vein, though my experience does not show that it is so likely to occur from this latter cause, especially if the vein has been cut across, as in amputation. There seems to be more chance of its occurring after ligature of a continuous vein. The symptoms of phlebitis are, first, pain in the part, and tenderness along the course of the vein. Red lines are seen stretching up the limb, from inflammation of the veins and lymphatics. Then acute œdema and tension supervene, with a sort of erysipelatous redness over the whole limb. In some forms of phlebitis, instead of redness, the limb is preternaturally white, swollen, and glistening. These phenomena are accompanied by constitutional symptoms, rigors, a peculiar faintness, a tendency to yawning, and a feeling of præcordial weight and oppression. Occasionally there is also some nausea, but this is not constant. There is not much headache at first, though it comes on secondarily.

If the phlebitis be less acute, the symptoms come on more slowly. If the vein be deep-seated, there may be no redness, but the pulse rises. In all cases it is very rapid and irritable. The tongue is brown in the centre, and red and glazed at the edges, from the irritative fever accompanying the disease. The patient complains of what he calls rheumatic pains in some joint. The shoulder-joint generally becomes first affected, next the elbow, and then the wrist. The rigors become more frequent, and there is an increase of all the irritative symptoms. In some cases, preceding the affection of the joints, the patient complains of great pain towards the right side and back, and over the liver, while at other times there are in the early stage symptoms of pneumonia and of abscess taking place in the lung. These conditions depend, in the first instance, on the direction of the circulation through the vein. The inflammation extends along the lining membrane, though this is denied by some, who hold that the lining membrane of veins is not liable to inflammation. I think we have evidence of that action in the diffuse redness of the lining membrane of the veins affected, thickening of their coats. We also find fibrinous deposits on the lining membrane of

veins, and very often in the right side of the heart, in cases of phlebitis, more especially in cases where the symptoms proceed very rapidly to a fatal termination, with pain and oppression and dyspnœa. In other cases, where the progress of the disease is slower, we have affections of the joints. Wherever there is a large venous circulation, there venous congestion and effusion take place, irritation is set up, and circumscribed suppuration or secondary abscesses follow. Hence we meet with such abscesses most frequently in the liver, lungs, and in the interior of joints.

In SUBACUTE, CIRCUMSCRIBED, or FIBRINOUS PHLEBITIS, the symptoms are not so severe or dangerous. The patient complains of great pain in the neighbourhood of the inflamed and swollen vein, and there is some constitutional disturbance. The pulse rises, but there is not so much fever as in the acute diffuse phlebitis, nor have we the articular affections taking place. These differences arise from the fact that in this form the disease has supervened on a chronic affection of the vein, giving rise to thickening and the deposition of a certain amount of fibrinous matter, and so blocking up the venous circulation. In many cases we even find abscesses forming in a vein, which we open just as we would any other abscess, without bad effects, and without a drop of blood escaping from the vessel, because the vein has been blocked up on both sides of the abscess by the fibrinous deposit, and thus the disease is localised. If, however, the disease be allowed to go on, and if the fibrinous deposit break up, owing to any freshly-excited action, then we have the acute diffuse phlebitis supervening on the chronic form of the disease, and the symptoms may become ultimately quite as rapid and disastrous as in the originally diffuse form of the disease. In the chronic form the action is limited in extent, but if it break through the barrier of fibrinous deposit, it may spread along the coats of the vein, or, what is still more dangerous, portions of the fibrinous clot may be displaced, and give rise to thrombosis or embolism.

The best *Treatment* of ACUTE PHLEBITIS, in the first instance,

is perfect rest, the application of leeches along the course of the inflamed vessel, and of acetate of lead and opium fomentations to the part. If it be a wounded vein, poultices should be applied over the wounded point. If there be any bogginess or tension, free incisions should be made. In the diffuse form of the disease, we generally require to give stimulants very early to support the patient's strength. In the febrile stage, opiates must be given. Formerly calomel and opium used to be given; but this remedy would probably cause absorption of any plastic effusion which might have taken place, and so prevent the disease from being localised, hence it would be more likely to do harm than good. In cases where the patient is not plethoric, muriated tincture of iron, in 15 or 20 drop doses in water, every four hours, is often very beneficial. In a great many cases, however, in spite of remedies, the symptoms continue till the joint-affections come on. Secondary abscesses and pyæmia supervene, and a fatal issue occurs.

In fibrinous phlebitis the local treatment is like that of ordinary inflammation—leeching, punctures or incisions, and fomentations. If any abscesses form in the vein, open them without any hesitation ; for, if you neglect to do so, the pus will break down the barrier surrounding it, and serious consequences will result from the passage of the purulent matter along the vein into the general circulation. After opening such abscesses in or over inflamed veins, the use of warm-water dressings and support by the many-tailed bandage, and absolute rest, form the principal indications of treatment.

LECTURE LXI.

Varix—Nature and Causes—Most frequent Sites—Aggressive Tendencies—Pathological Alterations—Risks attending the Varicose condition—Palliative and Radical Methods of Treatment—Use of the Vein-truss, and principle of its application—Obliteration by Ligature—Caustics—Subcutaneous Section and Acupressure—Hæmorrhage arising from Ulceration of Varicose Veins, and its Treatment—Abscess in Varicose Veins.

THE condition termed VARIX consists in dilatation of the veins, with impairment or destruction of the function of their valves, rendering them incompetent to support the column of blood. Other neighbouring veins become secondarily involved, till at last the limb affected with the varix has its veins distended and tortuous, and forming nodulated masses at different points. Between the tortuosities of the veins we generally meet with portions which are less affected or even healthy.

The vein most frequently affected with varix is the internal saphena. At first there is dilatation, and rounded projections corresponding to the position of its different valves, and gradually the vein becomes thickened and tortuous. On examining a vein in this condition, we find the valves shortened and thickened, as a consequence of alteration of the lining membrane, which forms the projecting portion of the valve. Varix is most frequent in the lower extremity, but is occasionally met with in the arm, arising from some peculiar cause, such as the pressure of an aneurism or other tumour on the veins of the arm, and also in some diseases of the chest and of the heart. The disease likewise occurs in the hæmorrhoidal veins, and then constitutes what are called hæmorrhoids or piles, which are originally a varicose condition of these veins.

Any cause which obstructs the returning venous circulation may lead to varix. It is stated to be more frequent in the left

than in the right leg, because the sigmoid flexure of the colon is placed on that side, and is said to press upon the left iliac veins, and so to cause varix of the left leg. The truth is, that the disease is almost as common on the right side, and the cæcum, if distended, would press upon the right iliac veins just as much as the colon would on those of the left side. Tumours of any kind may lead to varix. Tumours in the pelvis and in the abdomen, congestion or chronic affections of the liver, may conduce to varix, either in the form of piles, or of varicose veins in the lower extremities. Affections of the heart and lungs may, as already stated, also lead to it. Hæmorrhoidal varix is very common as a result of interrupted pulmonary circulation. In the female, pregnancy is a frequent cause of varix, and the disease often becomes permanent from a want of attention to the state of the veins in the interval between different pregnancies. During the first pregnancy the venous circulation is interrupted, the vein becomes dilated, but not much altered in condition. The valves are rendered temporarily incompetent, but not to any great extent; and after confinement, the cause of the venous obstruction being removed, the vein returns to its normal state. If the incipient varicose condition of the vein be not attended to after the confinement and during subsequent pregnancies, it will probably give rise to much after-trouble. The venous coats will gradually become thickened, the valves will be rendered permanently incompetent, and the varicose condition then becomes of a chronic established character.

The disease has always a tendency to involve other veins. The blood passing through a vein affected with varix is no longer sufficiently supported, the weight of the column of blood presses downwards, and leads to further distension of the vein. But the blood must be returned to the heart, and therefore it is thrown upon the collateral branches. The deep-seated veins are less liable to distension, as they are subject to the action of the surrounding muscles, which assists in returning the blood towards the heart. The collateral superficial branches therefore principally enlarge, their cavities become distended,

and their valves incompetent; and, indeed, the whole venous circulation of the limb is involved. The thickening of the coats of a varicose vein depends on chronic alteration taking place. When a vein is distended, it always relieves itself at first by watery, and afterwards by more plastic effusion. This exudation through the coats of the vessel occasions a certain amount of irritation, whereby chronic inflammatory action is induced, and the coats become thickened in consequence. The interior of the vein is altered, inasmuch as the valves are rendered incompetent, and are in many cases almost effaced. The varicose condition of veins is a very serious affection, as it leads to effusion and chronic solid œdema of the affected limb, and to the formation of intractable ulcers. It thus interferes with the usefulness of the limb, besides involving the risk of phlebitis, and occasionally of dangerous hæmorrhage from ulceration of the varicose vein.

There are two methods of treatment adopted in varix; one is *Palliative*, the other *Radical*. The former has for its object the removal, as far as possible, of all causes which may tend to keep up or aggravate the diseased condition. This indication is fulfilled by attention to the state of the bowels and liver, by relieving the affections of the chest which may be present, and by enjoining rest in the recumbent position, so as to favour the return of the blood towards the heart. Our local treatment consists in bandaging from the foot or hand upwards, so as to give support to the superficial veins, and prevent any further enlargement of them, thus causing their circulation to be carried on chiefly by the deeper veins, which are less likely to become varicose. Instead of bandaging the limb, we may use a thin silk or cotton stocking, with an elastic one over it. The latter must be well fitted from the ball of the toe to beyond the part where the diseased condition exists. The elastic stocking should be easy at the top, and rather tight below. By this means we give support to the veins, and enable the patient to move about without aggravating the disease. The elastic stocking, however, soon wears out, and a well-fitted laced

stocking, though more expensive at first, is better, and perhaps as cheap in the end. The laced stocking should fit well, and should have small pieces of whalebone let in at different points, so as to prevent dragging, and ensure an equable pressure. These form the principal palliative measures for ordinary superficial varix.

In varix affecting the deep-seated veins of the limb, where the femoral and saphena are both affected, and where there is a bulging at the upper part of the groin, great benefit has been sometimes obtained from the application of a small truss, with back lever-pressure, placed just over the saphenous opening, so as gently to compress the vein there. At first sight this has the appearance of interrupting the circulation, and might be thought likely to aggravate the disease. In such cases, however, we have to deal with a disease actually existing in which the valves have become incompetent, and where there is a column of blood above, which has a tendency to press downwards and increase distension. The truss prevents this gravitating tendency of the blood, and so does good. The use of the elastic or laced stocking should always be conjoined with the truss. The form of varix, however, in which the vein-truss is most useful, is that affecting the veins of the spermatic cord, termed cirsocele or varicocele. These veins are sometimes so distended as to resemble a hernia, though generally they have a tortuous, worm-like feeling. In some such cases we can completely arrest this condition in the earlier stages by the application of a proper truss placed over the inguinal ring. The truss is made to press upon the lower part of the canal, so as to prevent too much blood passing into the veins from above, but not sufficiently firm to prevent return of the blood upwards. This, along with an elastic suspensory bandage, produces very great benefit, and often saves the testicle from becoming atrophied. We must always remember that when we perform the radical operation on the veins of the cord, if we really obliterate all the principal veins, there is a great risk of atrophy of the testicle taking place, even though the artery be left uninjured. The venous blood

must be returned from the testicle ; if it is not, then the arterial supply very soon becomes diminished in quantity, and so the gland becomes atrophied almost as much as if the artery itself had been obliterated. Division of the falciform edge of the fascia lata has been tried as a palliative remedy in varix of the saphena, but not with much success, nor is the practice likely to be followed.

The *Radical treatment* was at one time very much studied, and various plans have been proposed. Amongst the earlier methods was that of cutting down upon the vein and tying it, but phlebitis very often resulted, and therefore ligature of the vein for the radical cure of varix was soon abandoned.

The next plan was to apply potassa fusa to the surface of the skin, over the affected vein, and leave it on till it made its way into the vein and caused obliteration of it. It was found that the caustic sometimes burned into the vein and caused hæmorrhage, and even when a clot formed, it was apt to break down and lead to secondary hæmorrhage, while in other cases extensive suppuration resulted, so that this plan also had to be given up.

Another method was to cut across the vein by subcutaneous section, without dividing the skin, and to place a pad of lint over the wound. Notwithstanding that the vein was completely divided, the circulation was sometimes restored through it ; but in a few cases obliteration of the divided vein occurred, and a successful result was obtained.

The plan most generally adopted now is to obliterate the vein with a harelip-needle, by a form of acupressure. The vein-clamp, as it is called, was used at one time to compress the vein laterally, but now it is never used. In the radical cure at present adopted, the needle is introduced below the vein, and a thread applied round it, as in the ordinary harelip-suture, so as to make mediate pressure on the venous coats, and not the direct pressure of the ligature, the skin being left between the needle and the vein. The needles are applied at the healthy parts of the vein between the tortuosities, and as many as six

or twelve are inserted in the leg, so as to obliterate completely the canal of the vein. This plan answers very well on the whole, but I have not the same anticipations of a radical cure being obtained from it as I once had. It is a radical cure of the varix in the vein affected, but not of the varix of the limb. Should the needle be allowed to make its way out, or should it be removed after a few days? Formerly it used to be withdrawn after about three days, when the vein was felt to be firm and consolidated, but it was often found that the portions of the vein between the needles were still pervious, and continued so after the removal of the needles. I adopt, therefore, the plan of allowing the needle to ulcerate its way through, making sure that it is placed quite below the vein and not through it, so as to ensure that the circulation has been absolutely cut off, and the vein completely obliterated. Still I do not look upon this operation as really a radical cure for varix, because the venous circulation must be carried on, and the deep-seated veins alone cannot possibly accomplish this. Thus, when one superficial vein is obliterated, others become visible, and begin to enlarge, and then over-distension leads to valvular incompetency and varix in them. Whilst, however, we cannot radically cure the disease, we can do a great deal in this way to bring about a cure. We can get rid of the veins principally affected, and then, by using palliative means to support the circulation, we can prevent the collateral branches becoming so distended as to give rise to much inconvenience. That is all I can say for the radical cure of the disease. It is not a true radical cure, except as regards the vein originally affected; and varix is a disease which we cannot expect to cure radically, for we cannot obliterate all the veins of the limb.

In cases of varicose ulcers, the first thing to do is to get rid of the varicose condition of the veins of the limb: without doing this we cannot expect to cure the ulcer; and in such cases the radical method of obliterating the veins principally affected is of great value.

In some cases of varix we have to consider the question of

hæmorrhage. Often at one point of the affected vein, a small, red, irritable spot appears on the skin, or in an ulcer over the vein, without much suppuration taking place. Without much warning this gives way, and when the patient is going about, profuse hæmorrhage, of a very dangerous character, may take place suddenly. If the patient continue in the erect or semi-erect position, it may even prove fatal, because it is not merely the blood from below that is escaping, as in venesection, but the whole superimposed column of blood above the opening flows out, so that the right side of the heart is rapidly emptied, and fatal syncope ensues. The flow is rapid, both from the proximal and from the distal side of the opening. The treatment of such a case is very simple. Place the point of your finger on the bleeding orifice, lay the patient in the recumbent position, raise the limb a little, and apply a bandage from below upwards, over a compress placed on the bleeding point, and you at once arrest the hæmorrhage.

Sometimes abscesses form in or around a varicose vein. These must be opened freely, like any other abscess. In the fibrinous phlebitis, the vein is blocked up both above and below the abscess, so that there is no danger of hæmorrhage when the abscess in the vein is opened.

In the radical cure for varix by the needles, it has been said that there is no risk of phlebitis supervening, but this is not strictly correct, for I have seen such cases. Whilst this operation is much freer from danger than any of the other methods of radical treatment, it is not absolutely without danger, for phlebitis does occasionally follow the operation.

LECTURE LXII.

Injuries and Diseases of Arteries—Their Anatomical and Physiological Peculiarities in reference to their Surgery—Collateral and Anastomosing Circulation—Wounded Arteries—Natural Hæmostatics: in a Completely Divided Artery; in Partially Divided or Punctured Arteries—Question of Surgical Interference where Arrestment of Bleeding has taken place—Torn or Twisted Arteries—Hæmostatic Process in such cases—Actual and Potential Cauteries and Styptics: their Mode of Action—Directions for Treating a Wounded Artery.

In speaking of the diseases of veins, I pointed out the necessity for bearing in mind their anatomical and physiological conditions. The same remarks apply with even greater force to the arterial system, in reference to the injuries and diseases to which it is liable, and to operations or other methods of treatment.

The points which I should wish briefly to recall to your minds on this subject are—1*st.* The structure of the arterial tube, and its function and source of nutrition. 2*d.* The cellular sheath of arteries, and its connection with the vessel. 3*d.* The peculiarities of the arterial circulation in reference to anastomosis.

For our present purpose, it will be sufficient to consider the artery as consisting of three tunics:—*a.* The internal serous or villous coat. *b.* The middle elastic fibrous or muscular coat. *c.* The external fibro-cellular coat.

The villous or serous coat presents a smooth free surface, and is covered with a slight moisture. Its smoothness favours the circulation of the blood through the artery. This lining membrane passes into the capillaries, and into every branch of the artery, and so long as it remains entire the circulation will in a great measure be uninterrupted. A very slight lesion, however, at any point of the lining membrane, will lead to an interruption of the circulation, and gradually to obliteration of the

vessel at the injured point, or to the peculiar form of disease called aneurism. The internal coat of an artery possesses considerable vitality, and has a peculiar viscid or plastic secretion. It has, indeed, no direct vascular supply, but receives its nutrition from the middle coat, which itself is supplied from the external tunic, by the blood-plasma from the vessels ramifying in the fibro-cellular coat. The internal coat is so closely connected with the middle coat as to be almost inseparable from it, except in some of the larger vessels. If we make traction on a vessel in the longitudinal direction, the internal coat does not yield because of its connection with the other coats, nor does it yield on transverse pressure; but if we apply sharp and direct pressure on the external coat and across the direction of the artery, the internal and middle coats give way as if cut with a knife.

The muscular elastic or middle coat is that which gives to arteries their peculiar rounded form and elasticity, and is met with in all the larger systemic vessels. It consists of yellow elastic or muscular fibre, arranged in circles, and is possessed of contractile power. An artery, when cut across, does not collapse like a vein, but remains with open mouth. This is due to the muscular coat, which gives firmness and resistance to the vessel, and serves, by reacting on the blood, as a means for carrying on the circulation, and preventing abnormal or irregular distension of the artery. If the *vis a tergo* were the only means of carrying on the circulation, the force of the blood would act more directly on some parts of the arterial system than on others, and the parts would yield, and distend irregularly. The muscular or elastic coat equalises the force of the circulation throughout the vessel, and so prevents any irregular distension, hence this coat is of very great importance. In regard to diseases of arteries, it is important to remember this, for the above conditions actually do take place when this coat becomes affected. It sometimes happens that the middle coat of an artery, for the space of an inch or so, becomes altered, and loses its contractility and elasticity, and has no longer any power of reacting on the circulation. The vessel, however, above and below this part

is quite normal, but at the diseased point it becomes distended, and forms an ovoid aneurismal pouch. The muscular coat has a great power of resistance as regards controlling the circulation, but it yields very readily to force, such as a ligature applied transversely; and also to great force applied longitudinally. Owing to the arrangement of the fibres, they are apt to separate from each other when such force is applied, and thus aneurisms are sometimes formed.

The external or fibro-cellular coat of the artery is very strong Its fibres are arranged both obliquely and transversely, and offer resistance to force applied in any direction, by direct traction, by ligature, or by compression. It is the most resistant coat of the artery, both physically and as regards its vitality, and requires a great deal of force to break or tear it. As regards its vitality, we have seen that neither the middle nor internal coats have a direct vascular or nervous supply, but the external coat has both. The numerous vasa vasorum derived from the cellular tissue of the surrounding parts run upon and into this coat of the arteries, giving it a peculiar net-like appearance on the surface. On this direct nutritive supply, derived from the vessels of the sheath, depends the vitality of all the coats of the artery—the middle and internal tunics receiving their supply secondarily from the outer one. In operating on arteries, anything in our manipulations which interferes injuriously with these vasa vasorum will always do harm by impairing vitality, and cause a risk of rapid ulceration of the coats of the artery, and therefore a great risk of secondary hæmorrhage. Hence the reason why the surgeon should always be very careful not to disturb the connections of the vessel with its cellular sheath, lest he destroy these nutrient vessels of the arterial coats.

The sheath of an artery consists of loose cellular tissue enclosing the vessel, and separating it from other textures. For example, we speak of a common sheath inclosing the carotid artery, the jugular vein, and the vagus nerve, but there is besides this a distinct septal sheath between the artery and the other structures, separating the artery from them. So it is with

every artery. Each has a layer of fine condensed cellular tissue surrounding it, and having vascular connections with it and the surrounding tissues.

The function of the arteries is to distribute the blood over every part of the body, and nature has provided that if the circulation be interrupted at any one point, there shall be other branches to carry it on beyond the interruption. This constitutes what is called the collateral circulation. In the femoral artery, for example, there are certain branches coming off from the profunda which are termed the collateral branches, and which run in directions somewhat parallel to the superficial femoral. These communicate freely with each other, by oblique or transverse branches, termed anastomosing branches, so that when the main trunk is tied the circulation is still carried on. The term collateral was originally applied specially to branches running parallel to the main artery, but now the terms collateral and anastomosing are used almost synonymously. I have mentioned this anastomosis of arteries as a provision in case of interruption to the circulation at any point, but its effects in cases of wounded vessels must also be kept in mind. Thus, when an artery is wounded, the blood at first flows freely from the proximal side of the wound; and if the vessel be tied there, the flow of blood is re-established from the distal side of the wound, in consequence of the free collateral circulation and anastomosis.

When an artery is wounded, the bleeding takes place much more quickly from it than from a vein. If the opening in the artery be of any great size, the blood—of a bright red colour—flows per saltum and very profusely; and the effect produced upon the system is much more rapid as regards the faintness and sickness than in the case of a wounded vein. The character and form of the wound will modify the effects. If the opening be a slit parallel to the direction of the vessel, and across the course of the circular fibres, then if the limb be on the stretch, comparatively little bleeding takes place; but whenever the limb is relaxed, the bleeding becomes profuse, and this

makes it difficult sometimes to find out where the wounded point is. On looking at a recent wound of this kind, when the limb is on the stretch, we cannot see any opening in the artery, but by relaxing the limb the bleeding takes place, and we can then discover the wounded point. If an artery has been wounded by a transverse incision, however small, the bleeding will be continuous and very profuse ; for in this case the circular fibres of the arterial tube separate from each other, and the opening gapes. In oblique wounds of arteries there is an intermediate condition between what occurs in the longitudinal and transverse wounds.

In regard to HÆMOSTATICS, let us first observe the method by which nature arrests hæmorrhage from wounded arteries. When an artery is completely divided across, there is a tendency, from the elasticity of the coats of the vessel, for the artery to retract within the cellular tissue around it, and also for its circular fibres to contract concentrically, so that the vessel becomes diminished in calibre, whilst it also retracts within the cellular tissue. These are most important conditions in arterial hæmorrhage ; for when a vessel is only partially divided, this process cannot take place, and hence the natural hæmostatics are not so efficient in such a case as when the artery is completely divided. In some few instances of punctured wounds of arteries, when the bleeding is comparatively slight, a clot forms in the vessel, and the hæmorrhage is arrested, but the chances are much against the natural hæmostatic process proving efficient.

When an artery is wounded, the blood flows very rapidly at first, and produces an effect upon the brain and on the centre of the circulation, because, from the equal way in which the blood is distributed throughout the body, the brain soon feels the loss of its blood, and therefore a feeling of nausea and prostration soon follows. The force of the heart's action is diminished, then the blood begins to flow more slowly, and the hæmostatic process commences, so that the faintness may be considered as part of that process. In a completely divided

artery the ends of the vessel retract within the loose cellular tissue in the neighbourhood, and within the loose cellular sheath surrounding the proper coats of the artery. A quantity of blood is thrown out in the cellular tissue, but at first, owing to the force of the circulation, it does not get time to settle there. As the faintness comes on, and the blood begins to flow more slowly, it collects in the cellular sheath and cellular tissue. Whilst this is taking place, the coats of the artery proper have not only retracted, but have also contracted towards the centre, so that the orifice of the vessel is almost closed, the middle and inner coats contracting and retracting more than the outer. There is thus a mass of coagulum within the wound, and contraction of the cut end of the vessel, which prevent any further flow of blood, provided the current be not very strong. If it is, the clot may be thrust out from the end of the vessel, and the bleeding renewed. Under more favourable circumstances, the blood which passes through the vessel is obstructed in its course, and thrown upon the collateral circulation which takes off a certain amount of the force of the circulation from the wounded point. The current of blood flows more slowly in the wounded artery. If the coats of the vessel be at all bruised, the blood soon ceases to flow through it; the vessel no longer re-acts on the current of blood, and a clot is formed in its interior, as well as externally. This clot only extends for a short distance up the vessel—never beyond the nearest large collateral branch—and soon becomes consolidated, and forms a firm plug in the mouth of the artery, while the fibrinous mass outside has also become consolidated, and so no further bleeding takes place. But, if the wounded artery be of large size, this natural hæmostatic process is not likely to prove efficient in arresting the hæmorrhage. In cases where a vessel is merely punctured the hæmorrhage may be more troublesome, for then there is no retraction of the vessel. If it be, however, a comparatively small vessel, the natural hæmostatic process will generally suffice to stop the bleeding permanently. The blood is thrown out, and a clot is formed at first in the loose

cellular tissue, and afterwards more directly between the cellular sheath of the artery and the coats of the vessel. This effused blood presses upon the artery, and so compresses its canal and diminishes or stops the current of blood passing through it. Sometimes the extravasated blood passes round the vessel, but generally it presses only on one surface of the vessel above and below the wounded point. In this way, if the clot consolidates, lymph is effused from the irritation and inflammation set up, and the part heals. But in a large vessel, so soon as the circulation becomes strong again, on the occurrence of reaction the clot which has formed will probably become displaced, and unless internal hæmostatic changes, from effusion of lymph and the formation of a clot within the artery, have taken place, secondary hæmorrhage will occur. It is important to remember this in treating wounds of arteries. If we meet with a wound of a large artery, like the radial, pretty high up, and if the bleeding be completely arrested at the time by a clot over the end of the vessel, should we tie the artery above and below the wounded point, or trust to the natural hæmostatic process? My own opinion is, that if the vessel be of a large size we should not trust to nature, but should at once secure it above and below. This is certainly the simplest and safest plan of treating such a case, for secondary hæmorrhage does sometimes occur even after temporary arrest by a clot, and then the vessel requires to be tied under less favourable circumstances, as, owing to infiltration, the parts become very much matted together, making it difficult to distinguish or separate one texture from another.

Some surgical authors say that it is unnecessary to tie the vessel until consecutive hæmorrhage has occurred, but I do not approve of this plan. Two cases in my wards last year* afforded good illustrations of the contrast between the two rules of practice. In one case the femoral artery was divided just where it becomes the popliteal, and a clot had formed in it, so that there was no bleeding at the time, but I did not

* 1867.

trust to this, because I felt sure that when the patient became less faint and the circulation got stronger, the clot would probably be forced away, and secondary hæmorrhage would occur. I therefore adopted the safer plan, and tied the vessel, thus avoiding any risk. In another case, where the brachial had been wounded, and the bleeding temporarily arrested, repeated hæmorrhage necessitated an operation a fortnight after the injury, and the operation was very troublesome owing to the alteration and matting of structures. (See Clinical Cases.)

Hence, in all cases of wounds of large arteries it is safer not to trust to the natural hæmostatic process, but rather to enlarge the wound a little, and tie the vessel above and below the wounded point. In wounds of small arteries, such as the radial low down, the natural process is generally sufficient to arrest the bleeding, but still, if we can get at the vessel readily, it is better to tie it, for it is always unsafe to trust to the natural hæmostatic process.

When arteries are twisted, as in lacerated and contused wounds, we have a form of artificial hæmostatic—*Torsion.* The external coat of the artery is twisted and drawn out, whilst the internal coats are divided, retract, and are thrown towards the centre of its canal. The elasticity and vitality of all the coats are impaired for some little distance above the wound, so that the current of blood in the injured vessel is diminished or altogether arrested for some distance, and bleeding is prevented at the first (Plate xxiii. Fig. 6). In such cases there is a variety of circumstances favouring the formation of the clot and other parts of the hæmostatic process, and hence there is not much necessity for applying a ligature. When, however, as in injuries, the great vessels are twisted in this way, the case is generally one which, for other reasons, requires amputation.

Such artificial methods of arresting hæmorrhage, as styptics, the potential and actual cautery, have all much the same action as the natural process—namely the formation of a clot and the prevention of bleeding for a time, allowing nature to bring about more permanent hæmostatic changes afterwards. The actual

cautery should be applied at a red heat only, not at a white heat, lest the slough should separate too soon. It impairs slightly the vital functions of the coats of the vessel at the injured point, a clot forms, and the circulation is arrested. But these methods are all imperfect; they are apt to cause suppuration and sloughing, and so produce secondary hæmorrhage; therefore, in all cases of wounds of arteries, the best plan is to tie the vessel above and below the wounded point with a couple of ligatures, or to employ acupressure by passing neeedles under the vessel. The reason for using a double ligature is on account of the free anastamoses between the different arteries. If we only tie the vessel above the wounded point, we partially arrest the bleeding for a time, but afterwards it comes on almost as profusely as before by the retrograde circulation from the distal opening of the vessel.

LECTURE LXIII.

Artificial Hæmostatics—Importance of the Subject—Historical Sketch and Review of the Principal Opinions which have been held regarding the Ligature of Arteries.

In my last lecture I spoke of wounded and torn arteries, and explained the processes by which nature arrests bleeding in such cases, constituting what is termed natural hæmostatics. I also alluded briefly to certain means used by the surgeon to assist nature and promote the arrestment of hæmorrhage.

The subject of Artificial Hæmostatics is one of the most important in surgery, and requires to be very fully brought before you. The use and effects of the ligature as the means most commonly adopted hitherto for arresting hæmorrhage, and still most generally practised, come first to be considered, and it will be well that I commence by giving you a historical sketch of the principal opinions which have been held regarding the essentials to the obliteration of an artery by ligature. I believe that a knowledge of the previous history of such investigations is absolutely necessary for their further successful prosecution, and this is too much neglected in the present day. In many departments of surgery there is a constant tendency of circumstances to revive, with slight modifications, doctrines and practice formerly inculcated, but which had been abandoned as imperfect or bad. Now, a knowledge of the history of the subject, by showing what were the comparative advantages and imperfections of such exploded doctrines and practice, and how far the objections which had formerly led to their disuse were well founded or the reverse, or how far these could be met by certain modifications, would do much to prevent the revival of what had on good grounds been abandoned as dangerous or useless. Such knowledge may, on the other hand, serve to point out the causes of

former failures and the means of obviating them, and so re-establish the practice on firm grounds.

The LIGATURE, as a means of arresting hæmorrhage or for the cure of aneurism, seems to have been used from a very early period in the history of medicine, although the ancients who mention the practice appear to have been guided by no distinct principle in its application. Indeed their ignorance regarding the circulating system generally must have prevented their arriving at any correct principle. But that it was used by them as a means of arresting hæmorrhage long previously to the times of Paré is incontestable. Celsus speaks of the ligature of wounded veins, Galen directs it to be used for wounded arteries; whilst Ætius and Paulus Egineta give directions for cutting down upon and tying arteries in cases of aneurism.

It is undoubtedly to Ambrose Paré, however, that we are indebted for reviving the practice of tying arteries—which had fallen into disuse—but even he seems to have directed little of his attention to the principle of its action, beyond its evident mechanical agency in preventing the flow of blood at the time of its application. This is scarcely to be wondered at, when we consider that the cases in which he used it were generally those of amputation or of recently wounded arteries, and as in such cases secondary hæmorrhage would be very rare, the new agent would appear so evidently superior to the wretched contrivances formerly used, that he would simply rest satisfied with its practical utility, without caring to investigate its *modus operandi.* When, however, the ligature came into more general use, and more especially when it came to be used in cases of aneurism, the secondary hæmorrhage which occasionally followed its application caused his more scientific successors to direct their attention to the subject.

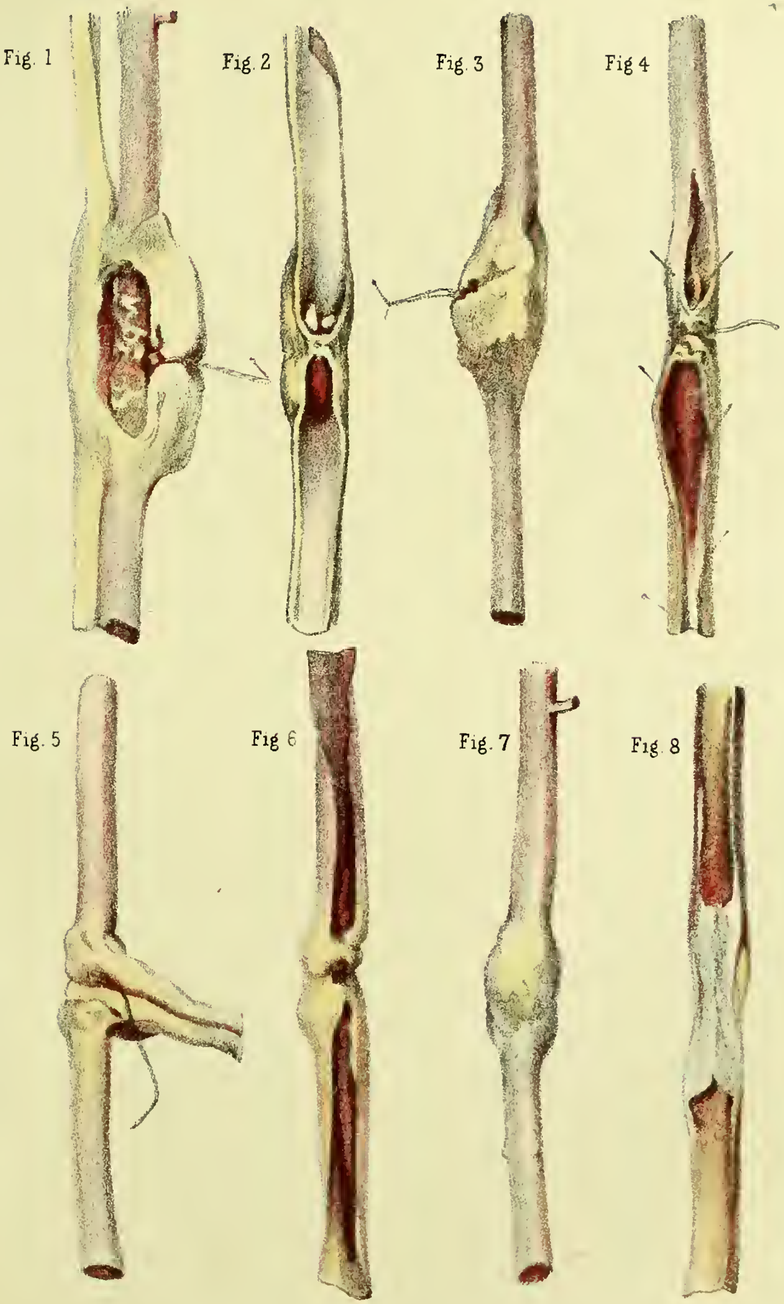
M. Petit seems to have been amongst the first of those who proceeded to investigate the question of the arrestment of hæmorrhage experimentally. The results of his experiments were communicated to the French Academy. He attempted to prove that the essential agent in arresting hæmorrhage was

the coagulum within the artery acting as a firm plug, and that this was the case by whatever means the bleeding was staunched, whether by cauteries, styptics, compression, or ligature. That the greater security of the last-mentioned agent over cauteries and styptics consisted in the form of the clot and the greater certainty of its formation. He concluded that, properly applied, compression was preferable to all other means as giving the best form of coagulum, and so preventing secondary hæmorrhage. In support of his views, he brought forward portions of arteries after amputation exhibiting the clots formed in them; and by other experiments regarding styptics, he tried to prove that they acted by absorbing the moist portions of the blood, and leaving a solid coagulum. Young, from expressions in his work on the virtues of turpentine as a styptic, seems to have held the same views regarding the coagulum being the essential cause of obliteration. A similar notion was entertained by Morand, who, however, thought the action was assisted by a peculiar contraction or corrugation of the vessel. M. Pouteau objected to Petit's views, and attributed the arrestment of hæmorrhage entirely to the condensation of the parts around the end of the vessel at the point tied. He says, "I have dissected a femoral artery three weeks after it had been tied in amputation, but in it I found nothing of M. Petit's clot; nothing to close or compress the artery, except merely the thickening of the surrounding cellular substance; for the ligature was loose about the artery, the canal was conical, for it grew narrow near the ligature."

This fact, noticed by Pouteau, was of great importance, as we shall afterwards show, had he only more carefully examined the nature of the condensation round the vessel. But unfortunately he considered it as furnished by the surrounding parts included with the vessel in the ligature, and this led him to the very dangerous conclusion that the more of the soft parts included in the ligature, the better chance would there be of safe obliteration. White, Kirkland, and Aitken, at first inclined to believe in the doctrine advanced by Pouteau, ultimately ascribed the

Plate XXI

HÆMOSTATICS EFFECTS OF LIGATURE



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arrestment of the blood and the obliteration of the vessel, even up to the collateral branches, to simple contraction of the diameter of the vessel: according to Mr. Kirkland, "nature suppresses hæmorrhages from divided arteries by the natural contraction of their muscular fibres."

Mr. John Bell, in his explanation of the action of the ligature, in the first volume of his *Principles of Surgery*, published in 1801, says:—"This process, then, may be explained in a few words: the ligatures applied round an artery operate by making the several points of the arterial canal pass through the several stages of inflammation, from adhesion in one point to gangrene in another." "The space included betwixt the ligatures" (he is describing the ligature of the brachial above and below the wounded point) "falls into gangrene; the space immediately under the stricture of each ligature adheres. This adhesion prevents the gangrene or the inflammation passing along the higher parts of the arterial canal; but the inflammation affects the arterial tube a little way upwards and downwards, so as to thicken its walls and contract its cavity, whence the canal of the artery is obliterated a little way beyond the exact place where it is tied."

"That arteries never bleed from the flat surface of an amputated stump, is a still more decisive proof of this doctrine; we pull out those with the tenaculum and forceps, tie them with a small thread, and pull that thread away by the third or fourth day (!). No one will suppose, when the ligature is drawn away, that such an artery is prevented from bleeding by a clot stopping the mouth of the artery, as M. Petit imagined; nor that the canal of the artery is compressed by the inflammation and thickening of the surrounding cellular substance, as alleged by M. Pouteau; for we draw out the artery, and tie it quite clear of any cellular substance, or muscle, or adjacent nerve." "The artery, when tied thus, can be obliterated *only by adhesion of its internal surfaces;* the part directly under the compression of the ligature unites by adhesion; the part below the ligature is destroyed like a polypus, fades and dies; and it is the fading of the lower part

thus mortified that allows the noose of the ligature to slip off on the third or fourth day."

From what has been said, it will be seen that even so late as 1800 the effects of the application of the ligature on an artery were not very distinctly or fully known. A great deal was conjectured or reasoned on from analogy ; and even of those who had founded their reasoning on experiment and examination of vessels which had been tied, whilst each of their theories contained, as we shall find, a certain amount of truth, all the investigators were led to conclusions more or less erroneous from over-estimating some one point of the process as *the essential ;* and apparently considering it necessary to prove this, by showing that those parts of it which had been noticed by others were of little value. The beautiful plan of operation for aneurism, proposed by Hunter in 1785, which was now coming into general use, and the occasional occurrence of secondary hæmorrhage which in some cases followed its performance, gave an impetus to the further investigation of the effects of the ligature.

In 1805, Dr. Jones published the results of an extended and carefully conducted series of experiments ; and his deductions, with very slight modification, constitute the opinions of the present day, except with those who advocate the use of the broad ligature. It had been shown by Desault and Bichat that an artery tied with a ligature always exhibited a division, or, as some termed it, a laceration, of its internal coats. This fact, pointed out to Dr. Jones by the late Professor John Thomson of Edinburgh, led him to investigate the subject by a series of experiments. The effects of the application of the ligature which he noticed, are given by him as follows :—1*st*, "To cut through the middle and internal coats of the artery ; and to bring the wounded surfaces in close apposition." 2*d*, "To occasion a determination of blood on the collateral branches." 3*d*, "To allow of the formation of a coagulum of blood just within the artery, provided a collateral branch is not very near the ligature." 4*th*, "To excite inflammation on the internal and middle coats of the artery by having cut them through, and consequently to

give rise to an effusion of lymph, by which the wounded surfaces are united and the canal is rendered impervious ; to produce a simultaneous inflammation on the corresponding external surface of the artery, by which it becomes very much thickened with effused lymph ; and at the same time, from the exposure and inevitable wounding of the surrounding parts, to occasion inflammation in them, and an effusion of lymph, which covers the artery and forms the surface of the wound." *5th,* "To produce ulceration in the part of the artery around which the ligature is immediately applied—namely, its external coat." *6th,* "To produce indirectly a complete obliteration, not only of the canal of the artery, but of the artery itself to the collateral branches on both sides of the part which has been tied." *7th,* "To give rise to an enlargement of the collateral branches."

The parts of the process which Dr. Jones principally insisted on as essential to obliteration of an artery without secondary hæmorrhage occurring, were—1*st,* The effusion of lymph within the vessel, caused by the degree of inflammation consequent on division of its internal coats, and the subsequent adhesion of their cut surfaces or cicatrisation of the cut made by the ligature. 2*d,* As subsidiary to and favouring this process, the least possible interference with the connections of the artery to its sheath, lest we injure its nutrient vessels, which pass from the sheath to the coats of the vessel. The effusion of lymph around the vessel, and the presence of a coagulum within it, he appears to consider as merely incidental circumstances. The former, he considers, may compensate in some measure in cases where the vessel has been tied with a single ligature, as for aneurism, for the advantage of retraction of the ends of a divided artery into the surrounding cellular tissue. But he does not seem to consider it as holding any very distinct place in the process of obliteration. He objects to broad ligatures, and foreign substances introduced between the ligature and the vessel, as not causing adhesion, but giving rise to slow ulceration, and thus to secondary hæmorrhage, as he considered the mere close apposition of the coats

would not excite adhesive inflammation. He also pointed out distinctly their bad effects in destroying the vasa vasorum of the artery, by insulating it too much, and by the profuse suppuration induced by large foreign bodies in the neighbourhood of the vessels. Strangely enough, his very dread of extensive suppuration seems to have led him to inculcate as useful a meddlesome interference which would have been almost as mischievous as that which he condemns. For at page 161 we find the following passage :—"It is obvious that every possible means should be employed to prevent the extension of this ulcerative process; hence, we should guard against the accumulation of pus about the extremity of the artery, by such pressure as the parts may conveniently bear; by placing the limb in such a position as will allow a ready exit to the pus; and in some instances *by the application of a sponge.*" Had he simply restricted himself to the second part of his plan—namely, attention to position—or at all events completely omitted the last, his advice would have been more in accordance with his own general views.

The views of Dr. Jones regarding the small round ligature were soon very generally adopted and acted on in this country. But, curiously enough, about the same time, and apparently without having seen Dr. Jones' writings, the celebrated Scarpa published his memoir on aneurism, advocating very opposite practice in the ligature of arteries—reviving, in point of fact, the almost exploded views which had previously given rise to the use of the *presse-artère,* and the other measures adopted by the older surgeons to prevent division of the arterial tunics by the too firm constriction of the round ligature. In speaking of the ligature as applied in cases of aneurism, he says, "By the ligature of the great arteries as a radical method of cure of aneurism, *I do not mean a noose, with which the artery is constricted circularly, but I wish to be understood to speak of a pressure made by a ligature of convenient breadth upon the artery, by means of which its two opposite sides are brought into mutual and firm contact, without the noose resting or pressing strongly*

upon the sides of the artery, which is *flattened* rather than constricted circularly; and it is in this manner that the surgeon avoids the danger of the rupture of the artery, and of a secondary hæmorrhage, and that he is assured of obtaining the approximation of the two compressed sides of the artery, as if they were two smooth planes placed one over the other, and that they contract an adhesion to each other." . . . . "Generally, on applying the ligature to any of the great arteries of the second order, besides the caution of compressing rather than constricting the artery circularly, the surgeon will recollect that he ties and constricts a living part, upon which the more he increases the degree of pressure, the more he accelerates the ulceration, and thereby the premature division of it. The degree of constriction ought to be such as to place the two opposite sides of the artery in firm contact, but still to preserve as much vitality as to resist the ulceration during all that time which is necessary for the adhesive inflammation producing the union of the sides of the artery, and at the same time the obliteration of its canal. After this time the ulcerative process detaches the ligature, together with a portion of the tied artery, but not a drop of blood is discharged."

The principle, then, which Scarpa inculcates as a preventive of secondary hæmorrhage, seems to be the necessity of preserving the integrity of all the arterial tunics, to prevent too speedy separation of the ligature, and merely to place the surfaces of the internal coat in sufficiently close apposition, that the degree of inflammation excited may cause adhesion between them. From other parts of his work, he seems to be fully alive to the value of preserving the vascular connections of the arterial tunics, and specially guards against too great disturbance of the parts around the vessel. Let us now judge, from his own description of the operation for ligature of the femoral, how far his method is consistent with such views. After describing the method of making the preliminary incisions for laying bare the vessel where it is overlapped by the sartorius, he goes on to say that the operator should "divide with one firm stroke the skin and cellular substance down to the thin aponeurotic expansion

of the muscle of the fascia lata, which covers the course of the superficial femoral artery; then, with another stroke of the bistoury, with his hand free and unsupported, or on a furrowed probe, he will divide along the thigh and in the same direction as the external wound the thin aponeurosis just mentioned, and introducing the forefinger of his left hand into the bottom of the incision, he will immediately feel the strong beating of the superficial femoral artery, and this, without the necessity of removing the internal margin of the sartorius muscle from its position, or at least very little." "*With the point of the forefinger of the left hand* already touching the femoral artery, the surgeon will separate this artery from the cellular substance which ties it laterally and posteriorly to the contiguous muscles; making the point of the same finger pass gradually under and behind the superficial femoral artery (supposing the surgeon has not enormously large fingers), he will raise it alone from the bottom of the wound, or, when it cannot be avoided, along with the great femoral vein." "If it is along with the femoral vein, holding the artery and vein thus raised, and almost without the wound, the surgeon, with a bistoury or spatula, or simply with the fingers of his right hand, will cautiously separate the vein from the artery, only in the space corresponding to the point of the finger which supports the artery." "He will then pass behind the denuded raised artery a large-eyed crooked needle, with a blunt point, carrying in the eye near to the point two waxed ligatures each composed of six threads." After this the surgeon will withdraw the forefinger of his left hand, on the point of which he kept the femoral artery raised from the bottom of the wound, and will proceed to the ligature of the artery." "He will stretch the two extremities of the tapes, in order to place them near each other; he will then make with each a simple knot, and before tightening it on the artery, he will place between it and the knot a small cylinder of linen rolled up, six lines in length and three in breadth, over which cylinder he will tighten both ligatures with a simple knot, and with such a degree of force as he thinks necessary to bring the opposite sides of the femoral

artery into complete and firm contact, not forgetting, however, that he compresses a portion of living solid."

"Over the first knot he will make a second, likewise a simple one; in making the simple knot, the surgeon is enabled to calculate the force which he employs in constricting the artery, which he cannot so well ascertain when he employs the double or surgeons' knot as it is called." "Having made the ligature on the artery, he will cut away the ends of the ligatures on a level with the skin, or will bring them towards the upper angle of the wound, and cover them with a bit of linen; he will cleanse the wound from blood, and wash it with tepid water." He will then fill the bottom of the wound with soft lint, and cover the lips of it with a pledget of simple ointment, and place over it a compress retained by the six-headed bandage."

Then, after directing the more immediate after-treatment of the patient, he goes on to say: "The insulation of the superficial femoral artery with the point of the finger passed behind and under that artery, corresponds nearly to the space which the two ligatures, placed near to one another, ought to occupy; therefore, from not destroying more of the cellular substance which binds the artery to the neighbouring parts, than is necessary for placing the two ligatures, the artery continues to receive its nourishment and life immediately above and below the place of the ligature; which is an inestimable advantage both with regard to the inflammatory course which the artery must pass through at the place of the ligature and near to it, and with regard to the desired effect depending on this inflammation—I mean, the adhesion of the opposite sides of the tied artery to each other." Again, in speaking of ligatures of reserve, he says, "I think that, far from doing good, the placing at the upper part the so-called ligature of reserve rather does harm; for this ligature destroys a great tract of cellular substance, and insulates the femoral artery more than is necessary."

It seems difficult to reconcile Scarpa's views regarding the necessity of insulating the artery only in the least possible degree with his advocacy of his rules for securing and tying the vessel.

The writings of Jones and Scarpa, advocating as they did such opposite practice regarding the kind of ligature to be used, and the method of preparing the artery for the ligature, drew considerable attention at the time, and gave rise to much discussion. The views of Scarpa were adopted on the Continent, and had also many supporters in this country; but the conclusions arrived at by Dr. Jones were, in this country, very soon generally admitted as correct.

LECTURE LXIV.

Historical Sketch continued—Investigations of Sir Astley Cooper, Travers, Lawrence, and Hodgson—Temporary Ligatures—Sir Charles Bell's Views—Double Ligature and Section of Artery, as recommended by John Bell, Abernethy, and Maunoir—Manec's Views.

Many investigations were undertaken with a view to test the correctness of the principles advanced by Dr. Jones, and to determine, if possible, points which the results of some of his experiments seemed to indicate, and which, if correct, would remove what still appeared to be imperfections in the ligature. To mention those who took part in these investigations and discussions, would be to enumerate the names of almost every scientific surgeon of the time, and would tend to little use. The names of Hodgson, Lawrence, and Travers, stand pre-eminent among those who adopted the views of Jones; whilst amongst the advocates of the broad ligature, we find along with Scarpa, Paletta, Crampton of Dublin, Roux, and most of the French surgeons. The doctrine that obliteration was caused principally by the adhesive inflammation induced by the presence of the ligature, with or without the division of the arterial coats; that this adhesion was complete within a certain time after the application of the ligature—which subsequently became not only useless but the principal cause of danger in consequence of exciting extensive suppuration in ulcerating its way out—led the advocates both of the small and broad ligature to investigate at what date adhesion was so far completed as to ensure obliteration, and whether the ligature might not then be removed so as to prevent ulceration taking place. In England this question was fully investigated by Sir Astley Cooper and Mr. Travers, the latter of whom made a series of experiments on the ligature of arteries, the results of which were published in

the *Medico-Chirurgical Transactions.* His conclusions in his first paper are as follow :—

"That the coaptation of the wounded surfaces of the cuticular coat of an artery, if preserved for a short period after the infliction of the wound, renders its obliteration certain, is a fair inference from these experiments. A more extended scale of inquiry, however, is required to establish the uniformity of their results. They afforded evidence that the circulation was arrested, by the absence of the pulse in the artery continuing after the removal of the ligature; and the vessel was therefore concluded to be as impervious as if the ligature had remained upon it. But upon this event I think it would be impossible to calculate with confidence, unless the ligature were suffered to remain upon the vessel for a time sufficient to insure the organised adhesion of its sides. In Jones's experiments, the return of the circulation was invariably ascertained after the removal of the ligature; and he seems to have regarded this as a proof that the subsequent obliteration of the canal was effected by a process independent of the coagulation of the blood. But in all these and similar experiments, the blood, as blood, has no concern in the obliteration of the vessel; the conical coagulum of blood is not formed in the first stage of the obstruction; its formation is gradual, and appears to require a change in the properties of the vessel consequent upon the abolition of its function. And although the presence of the conical clot satisfactorily demonstrates the obstruction of the canal, it is sometimes very inconsiderable, and at other times deficient, where the obstruction is complete. It is a mistake, therefore, to regard the coagulum of blood among the immediate effects of the ligature; it is an incidental consequence only of the permanent obstruction which it has been supposed to constitute; without which it never could be formed, nor, if formed, ever be competent to the purpose of permanently obstructing the canal of an artery."

Again, in his second paper, he says—

"It is now well known, that the result of tying an artery,

and removing the ligature instantly, is a wound or fissure of the middle and internal coats, which is soon occupied by lymph and gradually obliterated by cicatrisation, the vessel remaining pervious. But if three or four ligatures are applied contiguous to each other, forming as many distinct fissures, the lymph is effused in such abundance as to project into the cylinder, and obstruct the passage of the blood. . . . The obstruction of an artery may, I believe, be regarded as an invariable consequence of the application of a ligature for six hours, in the species of animals which were the subjects of these experiments. It is an indispensable condition, however, that the mode of applying the ligature be such as to ensure the division of the inner tunics, a condition which it will be more difficult to prevent than to execute, if the ligature be of a proper form."

He draws the following conclusions from his experiments :— 1*st*, "No material obstruction is opposed to the passage of blood upon removing the ligature at a period of six or even of nine hours from its application, and consequently its ultimate obstruction under these circumstances must be referable to the gradual completion of the adhesive process. 2*d*, The persistence of the ligature for a period of six hours affords direct evidence of an inflammatory action in the deposition of lymph between the divided tunics; which deposition is more abundant at nine hours, and sufficient for the obstruction of the vessel in twelve; presenting the form of an interstitial cord between the lips of the fissure, and continuous with it, a membranous septum extending across the vessel. 3*d*, "The septum of lymph is formed prior to the coagulum of blood, and in all cases of ordinary circulation is of itself adequate to the prevention of hæmorrhage; but under a sudden extraordinary impulse of circulation, or a violent concussion *ab externo*, is liable to be ruptured and give passage to the blood. If, however, an interval of six hours be suffered to elapse after the removal of the ligature, the same violence is not followed by hæmorrhage, although no coagulum of blood be formed. 4*th*, The cylindrical

coagulum of blood supporting the septum of lymph is an additional preventive to hæmorrhage under extraordinary impulses. It may be formed at twelve, or may not be formed at twenty-four hours; the nearest collateral branch being equally distant, and the obstruction equally complete in both cases. 5*th*, A period of twelve hours is sufficient for the obstruction of the vessel by lymph, so as to admit of the removal of the ligature, and the wound or division of the artery, without danger of hæmorrhage. 6*th*, The addition of the pressure of the ligature to the wound which it inflicts accelerates the adhesive process; thus, within a certain limit, the earlier the removal of the ligature, the more remote is the period of obstruction. If applied for six hours, it is unsafe to open the artery in less than twenty-four hours; if for twelve hours the artery may be opened immediately. 7*th*, The ligature applied for twelve hours upon the truncated artery is equally safe as upon that which is continuous. 8*th*, The coagulum of blood is larger and more extensive in the truncated than in the continuous artery, and is not bounded by collateral vessels, but extends into them; probably owing to the feebler propagations of the heart's impulse along the divided and retracted vessel, and the consequently greater quiescence of the fluid blood."

The same results, however, were not uniformly obtained by other experimenters, and although successful in some cases, when applied to the ligature of arteries in the human subject, in others the results were unfavourable. Mr. Hutchinson, in a case of ligature of the superficial femoral, removed the ligature at the end of six hours, and in less than a minute the artery became distended with blood, and fresh ligatures required to be applied; secondary hæmorrhage occurred, and the case terminated fatally. Sir A. Cooper found the circulation re-established after a period of thirty-two hours. Travers himself, in a case where he had tied the femoral artery, removed the ligature at the end of twenty-five hours, and was ultimately obliged to tie the vessel again in the usual manner to complete the cure. He therefore ceased to commend this practice, and as far as I know it has

been abandoned entirely in this country. But whilst the advocates of the round ligature in this country were giving up the use of the temporary ligature, Scarpa revived it on the Continent. From repeated experiments it was found that the broad flat ligature applied according to his plan, and withdrawn on the third, fourth, or fifth day, invariably effected complete obliteration of the artery. Paletta mentions two cases, one of ligature of the femoral, and the other of the humeral artery, in which the ligatures were removed on the fourth day. Both cases terminated favourably ; and Velpeau states that Scarpa, Biraghi, Molina, Fenini, Maunoir, Wattman, Fitz, Medoro-Solera, Roberts, and several other continental surgeons, had operated with success by this plan, in cases of aneurism of the carotid and femoral arteries. There can be little doubt that the removal of the broad flat ligatures and linen cylinders of Scarpa and his followers, at a period before their presence gave rise to excessive suppuration and ulceration, was a thing very desirable, where this could be effected without great disturbance to the parts, and might have in some degree obviated the other evils consequent on the broad ligature. We do not therefore wonder at Scarpa attempting to lay it down as a principle of practice in every case, as he must have found the bad effects of the continued presence of a large foreign body around the artery, and its removal was perhaps the less of two evils. But in cases where the small round ligature is used, its presence is comparatively free from risk, whilst the removal of the ligature is not, and therefore the plan, as I have already said, has been abandoned in this country even by its originators.

Next in the history of the ligature may be mentioned the attempt by Mr. Lawrence and others to diminish its size, and, by cutting off both ends close to the vessel, to allow the external wound to heal over it by the first intention. This was very readily effected in many cases, but unfortunately it was found that the small knot would not remain quiescent, for, however fine the silk employed, and however well the wound healed in the first instance, small abscesses formed till the ligature was expelled.

Sir A. Cooper in England, and Physick and Jameson in America, tried the use of animal and metallic ligatures, such as catgut, strips of deer-skin, threads of gold, silver, lead, and the like, in hopes that they might be absorbed or remain quiet, but the results hitherto obtained have all gone to prove that the ligatures must be expelled sooner or later, and that, like other foreign bodies, they are incapable of being absorbed. The plan of cutting off both ends of the ligature recommended by Lawrence, however, has been found useful in those cases where we do not wish or cannot hope to obtain union of a wound by the first intention, and where the presence of the ends of several ligatures would irritate the granulating surface as so many foreign bodies.

It now only remains for me, before I close this history of the ligature, to speak of the views of some surgeons who differ both from Scarpa and Dr. Jones as to some of the essentials for obliteration, or at least as to the mode in which the process is effected.

Sir Charles Bell, in his work on *Operative Surgery*, published in 1814, says:—"The principle which shall direct our endeavours in the stopping of hæmorrhage will be discovered, if the question can be satisfactorily answered, What is it which preserves the blood fluid in the vessels?" and he concludes by stating as his opinion, "that there is an influence of life in the coats of an artery, which prevents the blood adhering and coagulating within it; but that, when this natural influence is destroyed or disturbed, presently *the blood coagulates within the vessel*, and if the vessel be of moderate size, the flow of blood is obstructed." Adverting to the use of the ligature and its form, he says—"To the full effect of a ligature upon an artery it is necessary that the mouth be securely closed, and the thread in close contact with the coats of the vessel. In tying an artery firmly, the inner coats are cut through; but it is a mistake to suppose that it is necessary to the union of its coats, or that there must be, as it were, an incised wound to secure the adhesion of the sides of the vessel. When this notion was first broached, I cautioned my pupils against the next step; I thought an

attempt would be made to tie a ligature on the artery of an aneurismal limb, and take it off again; this has since been done and failed. I at the same time showed, that although any sort of injury to the coats of the vessel would in certain circumstances cause a coagulum to form, and the artery to be closed, yet, that so far from the cutting of the inner coat being the sole means of producing the union by ligature, it was not even necessary; for if the ligature was cast about an artery, and left without being drawn, so that the blood might still pass it, the consequences will be the inflammation of the coats, the formation of a coagulum, and the final closing of the vessel."

The parts of the process, then, which Sir Charles Bell seems to regard as essential are the two last mentioned—the adhesive inflammation of the coats, and the formation of a coagulum within the artery. With regard to the form of ligature, his rule of practice is, "proportion the ligature to the size of the vessel," apparently with a view to avoid division of the arterial coats. And in his work on the *Great Operations of Surgery*, published in 1821, in describing the operations for aneurism, he directs the ligature to be composed of "three strong silk threads laid parallel and waxed," which would form a small flat ligature; but he differs materially from Scarpa and his adherents as to the precepts he gives for operating, which may be summed up as follows:—That in exposing the vessel, the surrounding parts should be disturbed as little as possible. That the sheath be opened immediately over the vessel, and merely to a sufficient extent to disclose it. That, whilst the proper coats of the artery are exposed to the contact of the ligature, injury to its cellular connections and the vasa vasorum must be carefully avoided. That the parts be relaxed by attention to position of the limb whilst the surgeon passes the ligature, to avoid traction on the vessel; and lastly, that the loop and knot be *sunk into the coats* sufficiently to prevent the pulsation of the vessel shifting the ligature, but not drawn so tight as to cut the inner coats of the artery. In opposition to the practice advised by John Bell, Abernethy, and Maunoir, Sir C. Bell prefers a single ligature in

operating for true aneurism; and in a footnote at page 94 of his work on the *Great Operations of Surgery*, he makes the following remarks:—"Mr. John Bell and Mr. Abernethy, and M. Maunoir of Geneva, have been advocates for tying the artery twice and cutting it betwixt the ligatures. It is a practice which may have advantages, but the idea that they thereby made the artery as secure as when tied in amputation was undoubtedly a great mistake. Has the profession still to learn the difference of the condition of an artery, where the limb is cut off, and with it is removed the stimulus to the activity of the vessels, and of an artery tied in the centre of a limb, where the member still influences the condition and activity of the trunk and its branches?"

The latest, and one of the most elaborate, monographs on the ligature of arteries is that of M. Manec. He coincides in the opinions of Jones as regards the use of the small round ligature, and as to the effusion of lymph and union of the internal coats of the artery in the first instance. But he considers that these changes would, in themselves, be insufficient to prevent secondary hæmorrhage at the period of the separation of the ligature, and states that his experiments and observations led him to the conclusion, that the coagulum, together with its gradual and vital connections with the internal coat of the artery, form the essential part of the process of final obliteration.

After carefully describing the gradual formation of the clot, its increase in length in the first instance, and then in thickness from the centre towards the circumference of the canal of the artery, and the effusion of plastic lymph upon the internal coats of the vessel, until these come into contact, he states that "The first effects of the vital impulsion made upon the coagulum, and the coagulable lymph by which it is united to the sides of the vessel, begin to be visible between the sixth and tenth hour after their union is completed, and are indicated by the surface of the coagulum and the substance connecting it with the internal membrane of the vessel assuming a filamentous appearance, which soon becomes areolar. This gradual change of coagulated

blood into lamellated tissue extends through the successive layers of the entire substance of the coagulum; but previously to the central portion having reached this degree of vital organisation, red-coloured striæ appear in those parts which are nearest to the artery. These seem to be absorbent vessels, which slowly and imperceptibly take away the colorific principle of the blood, for the purpose of throwing it into the course of the general circulation; and when this substance no longer exists, the striæ lose their colour, become solid and much more resisting than before, and ultimately terminate in forming the basis of the fibrous web into which the coagulum is always changed. It is probable that each filament is formed of an obliterated vessel."

M. Manec then proceeds to show the necessity of such a coagulum being present at the separation of the ligature. "During the period that inflammation is extending upon the surface of the artery, it also penetrates to the centre of each of its extremities; but, as in this point it meets with the inflammation which has already taken place in the divided lips of the internal and middle membranes, its intensity is here increased and suppuration ensues; and thus the adhesion uniting these parts to each other and to the base of the coagulum is always destroyed. It hence appears that the means which nature primarily employs for obliterating the vessel entirely disappears; *and at this time the coagulum and its union with the internal membrane offer the only preservative against consecutive hæmorrhages.* The positive necessity, therefore, of the presence of a coagulum of considerable size to render the operation successful is evident, whether it shall have been performed on an artery of a large or middle size, as, for example, the crural and brachial."

LECTURE LXV.

Review and Appreciation of the different Opinions discussed—Results of the Author's original Investigations.

A REVIEW of the history of the ligature, which has formed the subject of the two preceding lectures, will be found instructive, as showing the gradual progress of any great doctrine towards perfection, although all the principal facts in the process may have been long known. When we look at the principles laid down by Dr. Jones as the results of his investigations, and for which he has received so much credit, it will be found that the great service he performed consisted not so much in pointing out any new fact observed in the process of obliteration of an artery, as in scientifically investigating the subject as a whole, ascertaining in a great measure the relative value of the different parts of the process, and drawing from his experiments sound practical deductions as to the causes of secondary hæmorrhage, and as to the best means of procuring obliteration. Each part of the process on which he insists had formerly been noticed, as we have seen, by one or other of his predecessors. Thus, the division of the internal and middle coats of the vessel had been fully pointed out by Desault, Bichat, and by the late Professor John Thomson; but the two former had regarded it rather as an imperfection than as tending to promote adhesion in its simplest form, whilst to Professor Thomson we believe Dr. Jones was indebted for being directed towards this inquiry. The coagulum within the artery, its shape and supposed value, had formed the subject of the extended investigations of M. Petit. From overrating its value, as the one essential, he had overlooked the other and more important parts of the process, and so was led to erroneous

conclusions. The external effusion and thickening around and upon the coats of the artery, and the occasional absence, and consequently the non-essentiality of the clot, had attracted the observation of Pouteau. But from his attributing this thickening to a wrong cause, and from not viewing it in connection with other parts of the process, he was led away from perceiving its true value and beauty in the operation (of which Dr. Jones also seems ignorant, and scarcely alludes to it except as incidental), and brought to advance a very dangerous practical doctrine.

Obliteration of the canal of the artery in consequence of the adhesive inflammation excited by the ligature—the part of the process so much insisted on by Jones—together with the ulcerative process for separation of the ligature, had been very fully pointed out by John Bell. And indeed, if we make allowance for the plan of operation he describes and his peculiar style of description, he seems to have almost forestalled Dr. Jones in regard to these particulars. Whilst, as regards the determination of the blood on the collateral branches, the ultimate enlargement of these, the manner in which the circulation is re-established above and below the deligated point, and all that regards the collateral circulation, Mr. Bell had left but little for any one to add. Nevertheless, it is to the investigations of Dr. Jones, as we have already said, that the profession is indebted for consolidating our knowledge of all that was truly valuable in the vague notions entertained by those who had investigated the subject before him, by pointing out the different steps of the process from first to last by direct experiment. And though, in common with others, he may not have estimated each part of the process at its true value, still the general principles he deduced as to practice are so correct, that, as they gained ground rapidly at first, they have stood the test of the past with slight modification, and are still likely to continue in favour.

The controversy caused by the publication of Dr. Jones's experiments, when the various statements of Scarpa and others are carefully examined, seems rather to involve the question as

to what are the best *means* of producing the same effects, than a difference of opinion as to the *cause* which he considered *essential* to obliteration. Both Jones and Scarpa point to the adhesive inflammation between the internal coats of the vessel, excited by the ligature, as the principal cause of permanent obliteration. And both insist equally on the value of the vessels of the sheath, (the vasa vasorum) as the source of the vitality of the artery, and consequently on the necessity of avoiding all unnecessary injury of these vessels. It is true that those who advocated Scarpa's plan of the broad ligature, in opposition to that of the small ligature recommended by Dr. Jones, seem to point to the division of the internal coats of the vessel described by Jones as the main difference and the principal point to be avoided. But Scarpa himself, when speaking of the broad ligature, whilst he insists upon the integrity of all the coats as *one* advantage, also points out what he considers another advantage—namely, the preservation of the vessels of the arterial coats from undue constriction—and is accordingly very particular in his directions as to tying the vessel sufficiently tight to flatten and bring its internal surfaces into contact, but not so tight as to constrict the vasa vasorum or divide the coats.

From what has been stated, the fallacy of Scarpa's practical deductions would, I believe, have been more readily recognised, had Dr. Jones and his followers, instead of insisting on the division of the two internal coats effected by the small round ligature as one of the essentials to obliteration of the vessel, contented themselves with pointing out that this result of the small ligature effected adhesion of the divided surfaces in its simplest form; whilst, from causing little disturbance of the sheath, the small ligature better preserved the integrity of the nutrient vessels of the artery; and that these advantages greatly overbalanced the supposed risk of dividing the internal tunics. Though all ligatures, even the broad ligature of Scarpa, produce division more or less complete of the internal coats, still there are sufficient facts to prove the statements of Bichat and Scarpa, and their followers, that this is not absolutely

essential, and indeed no one now doubts that the adhesive process between the coats of an artery, and consequent obliteration, may be effected without division of the internal coats of the vessel. This fact, however, by no means proves the correctness of Scarpa's doctrine as to the use of the broad ligature, for experience has shown that the complete division of the internal coats of the vessel by the small ligature really involves no risk, whilst, in respect to other points admitted by all parties, its advantages are incontestable. Laying aside, then, the advantages gained or risk incurred by the division of the internal coats, we find that both Scarpa and Jones agree as to the two great essentials necessary to obliteration of an artery :—1*st*, The excitement of inflammation, causing effusion and adhesion between its coats ; 2*d*, The preservation of the vasa vasorum as the source from which the arterial tunics are to receive their nutrition, and that vitality on which will depend the ability of the vessel to undergo the changes necessary in the process of obliteration. Both Scarpa and Jones seem to consider the clot as merely incidental. The expressions I have quoted from Sir Charles Bell's writings seem to indicate that, in his opinion, the formation of a coagulum within the vessel was essential to cause obliteration.

Manec is decided in expressing his opinion as to the clot being absolutely essential, for he states that his experiments led him to believe that the ulcerative process necessary for the separation of the ligature extends to and destroys the recent adhesions between the internal coats. And in the passages I have quoted he has pointed out carefully the successive steps in the formation and gradual organisation of the clot.

Having now presented a pretty full statement of the principal opinions at present held regarding the changes induced on an artery by the action of the ligature, and what parts of the process are absolutely essential, I shall next proceed to give you the results of my own experiments on this subject, and the views which these have led me to adopt as to the parts of the process absolutely essential to safe obliteration. I shall also state in

what respects they seem to elucidate some points on which a difference of opinion existed at the time when I entered on the investigation.

My experiments on the effects of the ligature of arteries consisted of two series. Of the first series, a brief abstract was published in the *Edinburgh Medical Journal* for June 1843. In it I sought more particularly to draw attention to two points which appeared to me to have sufficient importance to merit further investigation. These points were, the essential value of the external plastic effusion, and the non-essentiality of the internal coagulum.

The second series of my experiments was instituted to investigate still further some points which had not been quite satisfactorily ascertained in the first—namely, to ascertain the further process of organisation and vascularisation of the external plastic lymph—the various changes which the internal coagulum undergoes when it is present—the extent of obliteration in the deligated artery, and some questions connected with the collateral circulation.

The results of these experiments directed my attention more particularly to the relative value of two points in the process of obliteration of an artery by ligature—namely, the clot and the external effusion of lymph. When I commenced these experiments, I held the opinions expressed by Manec :—That the presence of a coagulum within the vessel, filling up its canal for some distance and ultimately becoming adherent to and incorporated with its parietes, was an essential to perfect obliteration and the principal obstacle to secondary hæmorrhage at the decidence of the ligature. My experiments showed me that, however common the presence of a clot, or however valuable as an accessory it might be when present, it was not an essential in the process. Inasmuch as the obliteration was as perfect, and without any occurrence of secondary hæmorrhage, in cases where the coagulum was wanting as in those where it was present. This caused me to re-examine some preparations which I had formerly made after ligature of arteries, and these

still further established the fact of the absence of the clot in many instances where the vessels were fairly obliterated. Thus, in two preparations, where the dogs had been killed about two months after ligature of both carotids and both vertebrals, I found that in both instances the vertebrals and one carotid were pervious close up to the deligated points; whilst, in each of them, one carotid (in the one instance the right carotid, in the other the left) exhibited the presence of a considerable clot.

In a stump of a leg which I dissected six weeks after amputation, I found the anterior and posterior tibial arteries pervious to common wax-injection up to the point tied, and contracted in calibre, but presenting no appearance of a clot. I have also in my own possession two specimens of femoral arteries eight weeks after amputation, where the stumps had cicatrised without the occurrence of secondary hæmorrhage. In one there is a large firm coagulum adherent to the sides of the arterial canal. In the other, there is not the vestige of a clot, but the artery is contracted towards the deligated point, and compressed externally by the firm lymph effused around its extremity (Plate xxiii. Figs. 1 and 2). All these cases seem to prove that the presence of the sanguineous coagulum is an incidental circumstance, and not an essential to obliteration of the vessel. Dr. Jones, it is true, had stated as his opinion that the clot was not essential; but of all his experiments with the ligature, I can only find one—namely, Experiment xiii. (page 155)—where there was no clot, and in that case the vessel is stated to have been much contracted and thickened in its coats. I had therefore regarded his statement more as a matter of opinion than as a fact proved by his experiments. Moreover, the value of the clot had been latterly more insisted on. The carefully-conducted experiments of Manec, and the deductions he drew from them as to the essentiality of the clot at the period of the separation of the ligature, seemed to me so plausible, that I had come to adopt them, and consequently, as I have already said, until I began these experiments, I looked upon the clot as the principal

obstacle to secondary hæmorrhage. But although I think that my experiments and the facts just stated sufficiently disprove such a view, it is well in all cases to investigate the causes of different opinions, and such an inquiry may serve to explain what I consider the source of fallacy in M. Manec's views. He proceeds upon the supposition that the primary adhesions between the divided edges of the tunics of the vessel are destroyed by the ulceration necessary to free the ligature, and that, consequently, if there be no clot to oppose the current of blood, secondary hæmorrhage must occur at that period. Now, I conceive that there are two errors in the views on which this theory is founded: 1*st*, That the internal effusion of lymph is limited to the mere union of the divided edges of the internal coats of the artery. 2*d*, That in the event of the primary adhesions of the internal tunics being destroyed, there would be nothing to prevent hæmorrhage except the clot.

As regards the former of these errors, it is doubtless to a certain extent true that the ulceration necessary to separate the ligature from the vessel will in most cases affect the recent adhesions immediately contiguous; but if the process goes on favourably, the suppuration is so trivial, that it can only do so to a very slight extent. The internal effusion of lymph, instead of being a mere layer uniting the divided edges of the internal coats of the vessel, is in fact of very considerable extent within its canal, sometimes from two to three lines in depth. So that, though the surface immediately in contact with the ligature be destroyed, there is still sufficient firmness of union to resist a considerable impetus of blood, and to prevent it passing through that part of the vessel at the separation of the ligature. This resistance is still further favoured by the other conditions of the artery at this period; these we shall notice immediately. The constancy of the existence of an internal coagulum of plastic lymph blocking up the canal of the vessel for some distance, and uniting the surfaces of the internal tunics beyond their divided edges, can be readily demonstrated, and is indeed generally admitted. I insist more particularly on this point, because, in

speaking of the coagulum, writers have not been sufficiently careful to distinguish between the true plastic effusion, which is constant and essential to safe obliteration, and the simple bloody coagulum, which is only incidental and not essential. The distinction between these two parts is best seen in a vessel examined from the ninth to the fifteenth day after ligature, in which there is a large clot. If such a vessel be opened immediately on the animal being killed, and a section of the coagulum made *in situ*, the distinction between the plastic and mere bloody coagulum is very apparent, even to the naked eye, and still more so when examined by a low magnifying power. In Plate xxii. Fig. 6, I have given a view of the femoral artery of a dog, at the seventeenth day after ligature, viewed by a low magnifying power, the drawing being made whilst the natural colours remained unchanged. In this artery the plastic coagulum, occupying its canal immediately above the point of deligation, exhibited on its section a peculiar gelatinous appearance of a yellowish-pink colour, perfectly distinct from the dark sanguineous clot which is seen lying in contact with it. It is necessary to keep in view these two distinct original portions of the coagulum, to understand their respective constancy and value in the process of obliteration, and also the subsequent changes which take place as to the vascularisation of the sanguineous clot when it is present, to which I shall have again to refer more particularly.

So much for what I consider the first erroneous notion on which M. Manec founds his views of the necessity of a clot within the vessel as essential to safe obliteration after ligature. His second proposition, deduced from the former, can, I believe, be shown to be almost as erroneous. For, even supposing the internal adhesion were completely destroyed by the process necessary for separation of the ligature, I hold there are other conditions of the artery which would guard against secondary hæmorrhage at that period. The walls of the vessel are thickened, and its canal contracted for a considerable distance beyond the deligated point; thus opposing a considerable obstacle to the flow of blood through it, a fact long noticed by many writers.

But besides this, I think the external effusion of plastic lymph, when its uses in the process are fully examined, will be found to be of itself sufficient to oppose a barrier to the occurrence of secondary hæmorrhage.

The effusion of plastic lymph on the exterior of the artery is a part of the hæmostatic process which my own experiments have shown me to be of great value, as tending to prevent secondary hæmorrhage, and as supporting and favouring the changes in the interior of the vessel. This has hitherto been very little attended to, and its true value overlooked; I therefore wish to enter more fully into a consideration of its gradual formation, and what appears to me to be its use in the process of obliteration of an artery.

Even so early as forty-eight hours after the ligature has been applied, we find that the lymph effused from the vessels of the sheath and neighbouring parts has enveloped the exterior of the artery, and begun to consolidate around and contract adhesions to the arterial parietes: that the mass of lymph extends for some distance above and below the ligature pressing upon the vessel; and on a section of the vessel being made, the lymph is found projecting into and filling up the groove formed by the ligature. At ninety-six hours, the plastic matter has become still further organised. It is firmer in structure and inseparable from the cellular coat of the artery, with which it is evidently incorporated, and a section of it shows it sending distinct bands of plastic matter from the part of the vessel below, to that above the point tied, as well as filling up the groove formed by the thread. If the vessel be examined when the ligature is separating, the lymph around it is found still further contracted and consolidated, and the portion projecting into the groove formed by the thread is found to have completely filled up the space from which the ligature has passed, forming the medium of union between the divided ends of the vessel. The knot of the ligature is found enveloped in a sort of cup-like cavity or cyst, and the ends of the ligature are enclosed in a tubular sheath of firm lymph, whilst the section of the vessel shows that the portion

of the external lymph situated between the ends of the artery has come in contact with the plastic lymph effused within its canal. When examined after the ligature has been discharged and the wound healed, we find the effused lymph beginning to undergo absorption and alteration in structure. It then presents much less bulk, and is of a fibrous appearance, and this fibrous appearance is very distinctly visible on making a section of it. There is now no apparent distinction between the internal and external lymph, which seem blended to form the new fibrous structure. At a still later period, say twenty-eight or thirty days after tying the artery, even the small knot of lymph between the ends of the vessel at the deligated point is completely absorbed, and a dense fibrous tissue occupies its place, uniting the ends of the artery divided by the thread. (See Plate xxi.)

From a consideration of these facts, I was convinced that the external effusion of lymph around the artery was of great importance in the process of obliteration by ligature, as assisting the internal changes. First, by pressing upon the vessel for some distance above and below the deligated point, it must necessarily diminish the calibre of its canal, and thereby lessen the impulse of the blood in the neighbourhood of the ligature; and this pressure and contraction will be gradually increasing as the lymph consolidates. Secondly, by becoming incorporated with the arterial parietes above and below the ligature, and projecting into the groove formed by it, it will serve in the first instance to support the internal plastic coagulum. Next, to commence the union of the ends of the vessel on either side of the ligature; and lastly, this plastic matter passing into the groove formed by the thread, enclosing the knot, and following in its track, will serve as a support to the internal adhesions at the separation of the ligature. At that period a sort of double action seems to be going on—the ligature ulcerating its way out, whilst the reparative process of effusion of plastic lymph, following in its track, keeps pace with its separations—a process in fact analogous to the old operation for fistula, with the gradually tightened wire. The reparative process literally following step by step in the track of the ulceration.

LECTURE LXVI.

Results of a Second Series of Experiments on Deligation of Arteries—Organisation and Vascularisation of the External Plastic Effusion—Its Vital Connection with the Internal Plastic Effusion and Blood-clot after decidence of the Ligature—Value of the External Plastic Lymph in the Process of Obliteration—Practical Deductions.

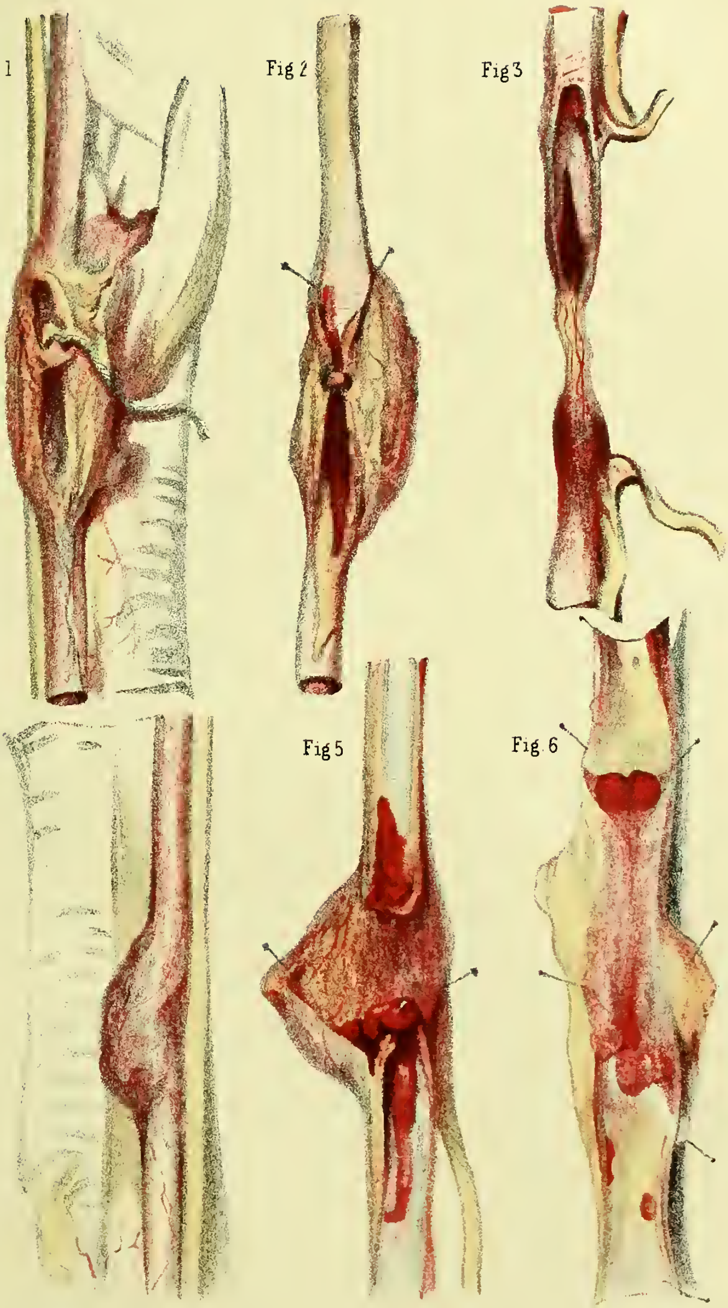
The Blood-clot: its Proper Function; its Value as an Adjuvant in the Process —Extent of Obliteration of a Vessel after Ligature—Practical Deductions.

My second series of experiments on the effects of the ligature, whilst it confirmed the results of the first as to the constancy of the presence of plastic effusion, and the changes which that effusion undergoes at different periods after the application of the ligature; shows further the mode of its development, and the manner in which it is fitted for the purposes which it is destined to fulfil.

The results of these experiments proved that the plastic lymph effused around the artery tied, becomes very rapidly organised and vascularised. Even at the lapse of sixty hours we find it traversed in every direction by a complete network of minute vessels ramifying in its substance, and passing from it upon and into the proper coats of the artery. These inosculate with the vasa vasorum on the arterial coats, assisting in their nutrition, increasing their vitality, and fitting them for the functions they are now called upon to perform. This great vascularity of the lymph evidently adapts it for the rapid development of new matter following in the track of the ligature, as the thread ulcerates through the cellular coat. When that has taken place, the newly-effused lymph serves as the medium through which vessels shoot into the internal plastic coagulum, and through it into the sanguineous clot, when it is present, —connecting these structures, and thus forming a firm union between the divided ends of the vessel (Plate xxii. Fig. 3). Later in the process, when the greater part of the lymph has been

Plate XXII

HÆMOSTATICS



absorbed, and its remains assume the form of the fibrous texture between the ends of the vessel, the new tissue is still remarkable for its vascularity.* The plasticity and vitality of the plastic effusion round the vessel fit it admirably for the reparative functions of nourishing and supporting the arterial coats, for aiding the internal changes requisite for obliteration, and for preventing the occurrence of secondary hæmorrhage, in case of the internal adhesions being disturbed. Of this I had an example in one of these experiments, where, from some cause, the union of the internal coats had been destroyed, and the clot displaced both on the proximal and distal side of the deligated part of the vessel; but where the consolidated lymph around the artery had completely prevented hæmorrhage taking place (Plate xxii. Figs. 4 and 5).

I consider that the facts and reasons I have stated sufficiently warrant my conclusion regarding the value of the external plastic effusion, as one of the essentials to the safe obliteration of an artery after ligature, but I am far from regarding it as pre-eminently THE essential, independently of the other parts of the process. For although in some of these experiments the external lymph seemed ultimately to be the only obstacle to secondary hæmorrhage, still, it must be recollected that in these cases the internal adhesions must have formed the barrier until it had been sufficiently consolidated to resist; and hence that, without the aid of these other parts of the process, the external plastic effusion would not, in itself, have been sufficient.

I have already said, that very little attention has been hitherto directed, in this country at least, to the value of the plastic effusion on the exterior of an artery after ligature. For although the constancy of the presence of that part of the process must have been noticed by all who have investigated the subject, they seem to have regarded it more as an incidental occurrence than as essential. Pouteau, indeed, had at a very early period noticed the closure of the vessel by means of the condensation around

* See Plate xxiii. Fig. 3.

its extremity, and had specially directed attention to it as essential. Unfortunately he had taken an erroneous view of the sources of that condensed structure, supposing in fact that it was derived from condensation of tissues included in the ligature along with the artery, instead of perceiving its true character as new matter effused from the vessels of the surrounding parts. Hence the erroneous and dangerous practical deduction which he drew from these false premises—namely, that the more of the surrounding parts included in the ligature, the greater the security against secondary hæmorrhage, doubtless did much to prevent future investigators from attending to this part of the process.

It now only remains, as regards this part of my subject, that I should point out some practical deductions as to the operation of tying an artery, drawn from a consideration of the development and functions of the external plastic effusion. *1st,* As the plastic effusion is furnished not only by the vessels of the sheath, but also, and principally, by vessels of the surrounding tissues in the deep-seated part of the wound, we must be careful to avoid, not only undue separation of the sheath from the arterial parietes, but also all unnecessary manipulation of the surrounding parts, lest we induce suppuration, which may either prevent the formation or end in the destruction of the lymph. *2d,* If the surrounding tissues, owing either to accident or disease, be in a state of impaired vitality, the requisite plastic effusion can scarcely be expected to take place, and tying a large vessel under such circumstances must always be attended with a risk of secondary bleeding on the separation of the ligature. Therefore, in some cases, the ligature ought rather to be placed on the vessel at some point nearer the heart, where it is surrounded by healthy parts. I am aware that this has been severely reprobated in cases of opened arteries, as where the vessel has sloughed in consequence of severe burns, or other causes, and where the unhealthy action is still going on. It has been said by Mr. Guthrie, that in such cases tying the artery higher up is bad practice, as the free collateral circulation

will infallibly give rise to retrograde bleeding from the lower part of the vessel. But it is equally evident, I think, that the ligature above and below the opening, in such a case, could not be expected to hold above two or three days; as from the impaired vitality both of the vessel, internally and externally, and of surrounding parts, there is no tendency to effusion of plastic lymph necessary for the reparative process. Unless, therefore, something be done to prevent the direct impulse of the blood upon the weakened part, secondary hæmorrhage would almost certainly occur. I consider it the better plan to tie the artery where it is surrounded by healthy parts, whilst we also apply ligatures above and below the ulcerated opening in the artery, so as to prevent retrograde hæmorrhage, and allow of proper dressing being applied to the parts. In this manner I treated a case of bleeding from the brachial at the bend of the arm, in consequence of severe burn, involving the limb up to the axilla. I placed ligatures above and below the opening in the brachial, and then tied the lowest third of the axillary artery. The lower ligatures separated on the third day, without hæmorrhage, that of the axillary on the thirteenth; and the patient did quite well.* *3d*, As the plastic effusion must depend upon the quantity and healthy character of the circulating blood for its development, it is evident that any state of the general system which will give rise to want of healthy action in the neighbouring parts, from the low state of the circulation, or which will alter the healthy character of the blood, must necessarily interfere with the development of the new formation, and impair its fitness for the functions which it has to perform, either by not furnishing it in sufficient quantity, or else giving rise to an effusion possessed of less plasticity than is requisite for the reparative processes it has to effect. Hence, whilst in the after-treatment of patients in whom large arteries have been tied, we avoid the use of stimulants as a rule, we must, on the other hand, be careful to give nutritious non-stimulating diet, to support the strength and furnish the healthy plasma necessary to effect the hæmostatic process.

* See Clinical Cases.

In the deductions drawn from my first series of experiments, I stated my conviction that the clot was not essential to safe obliteration of an artery, and I did so because I had repeatedly found it absent while no untoward occurrence had taken place during the process. But whilst I still look upon the clot as not absolutely essential to obliteration, it is so very generally present, and so obviously useful as an adjuvant to the other parts of the process when present, that it has always obtained a considerable degreee of attention, and various theories have from time to time been propounded as to its formation, organisation, and ultimate connection with the arterial coats.

To M. Manec we are indebted for the most carefully-detailed investigation on the subject of the coagulum. He regards it as acting as a firm plug within the vessel, ultimately becoming organised and adherent to its inner surface; and, according to his view, it is the only obstacle to secondary hæmorrhage at the period of separation of the ligature. As to this latter point, I have already shown that its presence cannot be absolutely essential, as it is frequently absent without secondary bleeding taking place, and that, even supposing the internal adhesions to be as completely destroyed as M. Manec supposes, at the separation of the ligature, the external plastic effusion around and between the ends of the vessel forms a sufficiently firm barrier to prevent the secondary hæmorrhage. In corroboration of this view, I would again refer to the experiment in the second series, where the internal adhesions had been destroyed and the clot displaced, and where the external lymph had effectually prevented bleeding. But apart from his peculiar view of the absolute essentiality of the coagulum, M. Manec's account of its gradual formation, and the general changes which take place in it and the part of the artery with which it is in contact, is corroborated in most respects by my own observations, in cases where the coagulum was present. I have not, however, observed the strong organised adhesions of the clot to the sides of the artery, remarked and described by Manec, till a late period. On the contrary, I have never found the coagulum firmly connected, except at its base, and this led me to examine more carefully as

to the progress of its vascularisation. The result was such as leads me to believe that vessels enter the clot from its base in the first instance, through the new and highly vascular lymph effused between the ends of the artery at the point from which the ligature was separated, and that the lateral adhesions to the inner surface of the vessel take place at a later period. Indeed, in my own experiments, I have never been able to trace any vascular connections between the sides of the clot and the arterial parietes. M. Manec admits that he has never been able to inject the connecting vessels, the injection having always become effused between the clot and sides of the vessel ; whereas, I have been able distinctly to see vessels entering the base of the clot. In one of my experiments of the second series, I traced them distinctly ramifying from the recent lymph into the coagulum (Plate xxii. Fig. 3). I believe, then, that the coagulum, when present, though not absolutely essential, is useful in assisting the process by acting as a plug and preventing the impulse of the blood upon the deligated point ; that afterwards it gradually becomes organised, and is incorporated with the arterial coats, and like them is subjected to vital changes, and gradually altered in structure.

As regards the Extent of Obliteration, Dr. Jones has stated, in his summary of the effects of tying an artery, that one is "to produce indirectly a complete obliteration, not only of the canal of the artery, but even of the artery itself, to the collateral branches on both sides of the part which has been tied." This statement has been repeated by almost every surgical writer since his time, as one of the constant effects of the operation. Now, I have no hesitation in saying that this statement is erroneous. It is not true (independently of peculiar circumstances) that an artery after ligature is constantly or even generally obliterated up to the nearest collateral branches on each side of the point tied, unless these branches arise at no great distance from that part of the vessel. In proof of this, I may refer to the preparations of the anastomosis after ligature of both vertebral and carotid arteries made by me, which are now in the University Museum; also to a similar preparation

in my own possession, and to several of my dissections of the arteries of stumps, which are contained in the Anatomical Museum of this University.

By looking at the preparations referred to, any one may satisfy himself that, even when there is a large extent of artery without any collateral branches to interrupt the process, the actual extent of obliteration seldom exceeds an inch and a half or two inches; showing that this is all the space which nature absolutely requires for the safe closure of an artery after ligature. Having thus compared the usually received statement with the actual facts of the case, I would now call attention to the practical bearing of these facts.

It has been said, that as a portion of artery which gives off many collateral branches is unfavourable for ligature, so, on the other hand, a vessel which gives off no collateral branches for a long distance is placed in the most favourable circumstances for the operation; as, owing to the great extent of obliteration, there will be little risk of secondary hæmorrhage from the impulse of the retrograde circulation. Now it is perfectly true, that if an artery be tied at a part where several branches arise in close juxtaposition with each other, there will be a great risk of secondary hæmorrhage; because, owing to the force of the retrograde circulation through the anastomoses, *obliteration never passes beyond the nearest collateral branch.*

If we dismiss, as incorrect, Dr. Jones's statement that the obliteration *always extends up to* the next collateral branch, then it will be perceived that the truth of the second proposition above mentioned does not follow, because the absence of collateral vessels does not necessarily increase the extent of obliteration beyond certain limits, whilst in other respects it may prove injurious. I think it is not difficult to show, that in vessels near the heart the risk of secondary hæmorrhage will be greater in an artery which gives off no collateral branches than in one which does, because, if these are not so near each other, or so near the place of ligature, as to interfere with the essential parts of the process of closure, they will be positively useful in breaking the direct force of the current of the circulation,

and in obviating its impulse upon the deligated part of the artery. Perhaps my meaning will be better understood by referring to particular arteries. Let us, for example, compare the case of ligature of the common carotid artery with that of the external third of the subclavian. Here we have two vessels, both in the vicinity of the centre of the circulation, but I believe, *cæteris paribus*, that there will be less risk of secondary hæmorrhage in the case of the subclavian than in that of the carotid, because, in the former, there is sufficient space free from collateral branches to admit of the process of firm closure of the artery, in other words, there is as much space as nature generally uses for obliteration; whilst the direct aortic impulse on the deligated point and the newly formed structures is diminished just in proportion to the number and size of the branches given off from the subclavian on the cardiac side of the ligature. The current of blood passes into these branches, where it meets with no resistance, instead of beating against the recent adhesions in the newly-obstructed part of the artery. The common carotid, on the other hand, presents an example of a long arterial tube giving off no collateral branches. In it therefore, when tied, the deligated point is exposed on its proximal aspect to the full and direct force of the cardiac impulse; whilst, on its distal side, it receives the collected force of the blood poured into it from the retrograde circulation through the various branches of the external and internal carotids and their anastomoses.

For these reasons, and from observation of the fact stated with reference to extent of obliteration, I have come to the conclusion—That, whilst a very short space between the collateral branches is unfavourable for ligature, a very long extent of artery without branches is not necessarily so favourable, in vessels near the heart, as a moderate space, say from an inch and a half to two inches according to the size and position of the artery, with collateral branches on either side of the ligature; as the presence of these branches is useful in diverting the impulse of the circulation from the deligated point.

LECTURE LXVII.

Changes in the Collateral Vessels and their Anastomoses after Ligature—The Apparent Formation of new Vessels in such Cases—Effects produced in neighbouring Structures by these Changes—Their accompanying Symptoms—Summary of the Effects of the Ligature.

One of the first effects of the ligature of an artery, and one which has been admitted by all investigators to be of constant occurrence, is the distension and enlargement of the collateral vessels and of all their anastomoses. This effect is easily explicable by mere physical laws, for it is obviously the result of the general law which regulates fluids—that they pass in the direction where there is least resistance. Hence, it is obvious that the current of blood propelled through the canal of an artery, when it meets with the complete obstruction caused by the constriction of the ligature, is of necessity forced upon the collateral vessels through their anastomoses with the artery tied, on the cardiac or proximal side of the ligature. As the pressure of the blood in these collateral vessels is equal in all their ramifications, the consequence is, that their branches which communicate with the artery on the distal side of the ligature also become distended and empty themselves into the canal of the artery beyond the deligated point, thus indirectly re-establishing the circulation in it. But whilst the physical cause of this effect is evident and admitted by all, there are many points connected with it, and the uses which nature makes of this change for effecting the process of obliteration, and for carrying on the obstructed circulation by new channels, which are of great interest. I believe that its effects upon organs in the vicinity of the artery tied, will, if carefully examined, also serve to explain some phenomena occurring after the ligature of particular arteries which have been referred to other causes.

As I have already discussed the effect which this increased vascularity produces in the effusion of plastic lymph around the deligated part of the vessel, I shall not recur to that further, but restrict myself to the consideration of three points under this head—1*st*, The process of the re-establishment of the circulation as deduced from examination of the anastomoses at different periods after the application of the ligature. 2*d*, Whether these anastomoses are sufficient in all cases to effect such re-establishment, or whether in some cases new vessels of direct communication be not formed to supplement the existing anastomoses, as described by Dr. Parry and others. And 3*d*, The consideration of the effect of the distension of the collateral branches and their ramifications on the neighbouring structures, as explaining, in some cases, symptoms of diseased action occurring after ligature.

As to the first of these questions, we find that the enlargement of the collateral vessels and their anastomoses differs much, both as to degree and general diffusion, according to the period after the operation at which we examine the parts concerned. If, for example, we dissect a carefully-injected preparation, say at the distance of a year or two after the arteries have been tied, we do not find any very unusual general vascularity. For the most part, we find only some of the greater and more direct inosculations considerably enlarged, and serving to keep up the circulation through the artery which had been tied, and in which it is now completely re-established. But such a dissection exhibits merely the result, not the phenomena of the gradual process by which that result has been accomplished; and to understand the gradual changes, we must examine such preparations at different periods in the process.

When we examine the parts in the neighbourhood of an artery which has been recently tied, that is, during the first eight or nine days after the operation, we find all the tissues highly injected and presenting the appearance of a network of turgid vessels. This vascularity is diffused over every part, and the more direct anastomoses, though distended in common with the rest, are by no means so much enlarged as we might be led to

expect from examination of preparations made at a later period. This increase of the general vascularity is constant, and I have proved it not only by dissections of minutely-injected parts, but also by observing the great difference in the amount of bleeding which takes place on cutting down upon one carotid artery some days after the opposite vessel had been secured. In the normal state of parts there is scarcely any bleeding, whilst in the cases where one of the arteries has been previously tied, the general arterial hæmorrhage is very copious, and vessels of the skin and other tissues often bleed *per saltum*. At a later period, from the fourth to the eighth week, the vascularity becomes less general, and the more direct collateral inosculations are now found to be very considerably enlarged, sometimes to three or four times their natural size; whilst their parietes are tender, more easily torn, as if thinner in structure in consequence of distension. The vessels which are then principally enlarged are the primary and direct collateral arteries, and their anastomoses, and some of the secondary collateral inosculations, as those communicating with the vasa vasorum, and the neurilemmal vessels of the larger nerves accompanying the artery which has been tied, or existing in its immediate vicinity. At this period the circulation has been completely re-established, filling the tied vessel above and below the obliterated point; and, as I have elsewhere stated, not only beyond the collateral inosculations on either side, but also between them and the part tied, where there is a long portion of the artery without collateral branches. After a still greater lapse of time, the primary and direct anastomoses form generally the only remarkable vessels, and even they, I am led to believe from my own observations and dissections, gradually decrease, with the exception of perhaps a few of the most direct. At least they certainly do not increase in size after the eighth week; for in the preparations I have dissected at a considerable period after ligature, the anastomoses, with two or three exceptions, were not so large or numerous as in similar dissections where the animal had been killed at the end of six or eight weeks after the arteries had been tied.

The following appears to me to be the *rationale* of the facts I have just stated. By the sudden and complete obstruction of a large arterial trunk, the blood usually passing through it is forced upon the collateral vessels and their anastomoses. And as the more direct communications are not sufficient at first to carry the whole quantity back into its natural channel, the pressure of course forces it also into all the neighbouring vessels, and so gives rise to the general diffuse vascularity. Thus, not only is the circulation to the parts beyond the ligature provided for, but another purpose is fulfilled. The vitality of the arterial coats and of the tissues around the vessel is increased, and they are adapted both for resisting too rapid ulceration, and for furnishing new products necessary for the safe completion of the process of obliteration. When these first indications are fulfilled, and obliteration has taken place, diminished vascularity and absorption follow, and the office of carrying on the circulation is then performed by the larger and more direct anastomoses, which have gradually become sufficiently dilated for that purpose by the more direct pressure of the blood upon them.

Some investigators differ from these views, as regards the sufficiency of the existing collateral branches to re-establish the circulation in a large artery which has been tied. They consider that in such cases nature assists these existing vessels by the formation of new direct arterial communications between the cardiac and distal portions of the artery. This opinion is founded upon the appearance of short vessels passing directly from the point of the artery immediately below the obliteration, to the point immediately above it; and they reason, that new vessels would not be created if the existing channels were sufficient for the purpose. As it has been proved repeatedly in the dead body, that, even with coarse injections, the existing anastomoses will serve to fill the distal portion of an artery which has been tied, I think it needless to insist on a fact so well demonstrated further than to point out the source of the fallacy on which the opinion I have alluded to is founded. This I can do by showing that the supposed new vessels occasionally seen are in reality

only portions of vessels previously existing, and it will be best done by tracing the manner in which this appearance occurs.

In dissecting one of my preparations after ligature of both vertebral and carotid arteries, I was struck by the appearance of one of these supposed new vessels arising from the lower portion of the left carotid just below the obliterated point, ascending parallel to it, and again terminating in it immediately above the obliteration, and having no apparent communication with any other vessel. I did not even then feel satisfied of its being a new formation, because I had noticed during the dissection that it passed upwards upon the vagus nerve, and hence, although I could trace no other branches communicating with it, I suspected it to be merely a portion of one of the vessels of the sheath. That the opinion I then entertained was correct I have since had decisive proof. Before proceeding to dissect the anastomoses after ligature of both carotids in another case, I first threw in a very fine-coloured size-injection, which was followed up by one composed of wax and varnish, so as to insure the injection of the most minute inosculations. As I had anticipated, the real nature of the short communicating vessels between the ends of the obliterated artery was then very readily made out. On both sides of the neck in that preparation a branch of the ascending cervical artery was seen to pass upwards along the course of the vagus lying between it and the carotid artery, more closely attached to the nerve but sending off twigs to both. Immediately on the cardiac side of the obliteration there was a very large inosculation between this ascending vessel and the vasa vasorum, and a similar anastomosis occurred immediately above the obliteration, and then the ascending artery became much smaller, and was gradually lost upon the vagus. Now it appears to me pretty evident that, if I had not taken the precaution I have mentioned, in injecting the vessels with size before throwing in the wax, the appearance would just have been similar to those in the former preparations. In other words, only the larger portion of this anastomosis would have been injected, and it would then have

presented the appearance of a direct communication between the two portions of the carotid, and its connection with the ascending collateral branch would have been lost. Any one who compares the two preparations I have alluded to, or looks at Fig. 3, Plate xxiii., will have little difficulty in determining the true nature of these supposed new vessels described by Dr. Parry and others, and in coming to the same conclusion as I have done—That they are not new vessels, but merely portions of the enlarged inosculations of previously existing vessels of the sheath.

Lastly, we have to consider the effects which this alteration in the circulation produces upon organs in the vicinity of the obstructed artery, and the symptoms to which these effects may sometimes give rise. I have shown that, immediately after the application of the ligature, the blood which formerly passed through the obstructed vessel is thrown upon and distends all the vessels in the neighbourhood, thus giving rise to a great increase of vascularity in the surrounding textures, and consequently more or less affecting their functions. But of all the tissues, we find the nerves to be most affected by this increased vascularity. The vessels of the neurilemma and their ramifications amongst the fibrillæ of the nerves are generally very much distended from the first, and continue to be so for a very considerable period after obliteration has been accomplished and the general vascularity diminished. This is more especially the case with those nerves which are in immediate contact with and run parallel to an artery which has been tied. If we reflect for a moment, it must be evident that such distension of the neurilemmal vessels and increased vascularity of the nervous texture can scarcely fail to give rise to irritation and corresponding symptoms in the organs to which such nerves are distributed. To this cause the neuralgic pains which occur after ligature of the arteries of the extremities have long been very generally referred. But it is not a little singular that the influence of the same cause has been so little attended to with reference to nerves of special functions. I here particularly

allude to the investigations into the causes of the symptoms and lesions so frequently noticed after ligature of the carotid arteries. From the time that operation has been practised, the very general, almost constant occurrence of cough and laryngeal irritation, or difficult deglutition, and not unfrequently pulmonary congestion, has drawn the attention of surgeons to this subject. The late Sir Charles Bell supposed that the sense of constriction and suffocation sometimes felt arose from an increase of the aneurismal swelling during the first days after the operation. But this could not account for these symptoms, as they occurred in cases where the artery had been tied for other causes.

Next, an opinion was pretty generally entertained that, in consequence of the irregularity of the cerebral circulation after ligature of the carotid, the functions of the brain were disordered, and that the respiration was affected secondarily through the medium of the pneumo-gastric nerve. But why, Professor Miller has well observed, that unfortunate nerve should have been singled out as the representative of the general cerebral irregularity, was never very clearly explained.

Of late years attention has been again directed to this subject by the researches of M. Robert (de Lamballe), and also by the late Professor Miller of this university.

M. Robert found in the experiments he performed that the most frequent lesion was pulmonary congestion, and he inferred that this results from the lost balance of circulation consequent upon the obstruction of these large vessels in the immediate vicinity of the heart. Professor Miller coincides with M. Robert's views.

Now, whilst I am not disposed to deny that the cause assigned by M. Robert and Professor Miller may, to a certain extent, influence the propagation of these symptoms, I cannot admit it as being the only or the primary one. Otherwise, we ought to meet with the same symptoms as frequently after ligature of the subclavian as of the carotid, and indeed, in some degree, after the ligature of every large vessel; for in all such operations the

general circulation is affected. I think that these gentlemen have overlooked the first link in the chain of diseased action, the source of direct irritation. In short, I believe all the symptoms of laryngeal, bronchial, and pulmonary irritation, after ligature of the carotid, may be accounted for, in the first instance, by reference to the same law of nervous irritation which has been so generally acknowledged in regard to the painful symptoms in the extremities after ligature. This arises in consequence of the increased vascularity of the nervous structure and distension of the vessels of the neurilemma. And when we reflect upon the close proximity of the pneumo-gastric to the carotid artery, the great increase of vascularity which it exhibits, and the pressure of the plastic effusion upon it after the application of the ligature, we may easily comprehend how these will act as a source of direct irritation to that important nerve, deranging its functions, and giving rise to symptoms of irritation or disease in the respiratory organs to which it is distributed.

As to the pathological conditions found in the cases examined by M. Robert and others, we must bear in mind that different causes may produce the same effect. Of one thing at least I am quite sure, from considerable practice in experiments upon the pneumo-gastric—namely, that all the symptoms and pulmonary lesions described by M. Robert are produced with equal certainty by irritation or injury of that nerve as they could possibly be by the cause he has assigned. Whilst the ligature of other arteries equally deranging the circulation, but more remote from the pneumo-gastric nerve, are not so generally attended with these symptoms of disordered respiration.

Having thus concluded my remarks on the special parts of the process, I shall give a summary of what I hold to be the essential effects of the ligature of an artery, according to the results of my experiments. 1*st*, It divides the two internal coats, which retract, and are puckered inwards. It constricts, without breaking, the cellular coat, so as to completely prevent the circulation through the vessel, the blood previously flowing through being determined on the collateral branches, which

become enlarged. *2d,* Plastic lymph is effused on the exterior and interior of the vessel tied. In the interior, between the cut edges of the internal coats, and also on their internal surface, for some distance on each side of the ligature, uniting these coats and forming an internal mass of plastic organisable lymph, on the exterior of the vessel, compressing it in the vicinity of the ligature, acting as a medium of nutrition, gradually consolidating round the artery, contracting closer adhesions to and ultimately becoming incorporated with its external coat, filling up the groove formed by the thread, and following in the track of the ligature as it ulcerates through the part upon which it is immediately applied. This external effusion of plastic lymph unites the ends of the artery divided by the ulcerative process, and supports the internal plastic coagulum and its adhesions at the period of the separation of the ligature. It becomes blended with it, being gradually diminished in bulk and altered in structure, so as ultimately to become an impervious fibrous cord. *3d,* The ligature causes complete obliteration of the vessel at the point tied, and for some distance above and below that point, such obliteration never passing beyond the nearest collateral branch, but not necessarily extending up to the nearest collateral branches, if these are remote from the point tied—the whole space of the vessel, which is completely obliterated, seldom exceeding an inch and a half or two inches, although there may exist no collateral branches to oppose its further obliteration. *4th,* It causes enlargement of all the collateral branches in the first instance, by which two purposes are effected :—The circulation formerly carried on through the tied vessel to the parts beyond the ligature is then carried on by the anastomoses of its various collateral branches, and so re-established. The vessels of the sheath and vasa vasorum also become enlarged, increase the vitality of the arterial coats, and adapt them for the changes requisite for safe obliteration. Subsequently the smaller vessels contract, and resume their natural size and functions, whilst the circulation is re-established in the main trunk, principally by the anastomoses between some of the larger collateral branches.

LECTURE LXVIII.

Torsion—Principle on which it is founded first introduced by M. Amussat—His Method of Operating recently revived as a Substitute for the Ligature—Acupressure as introduced by Sir J. Y. Simpson—Different Methods—Wire Compress.

Consecutive Hemorrhage: Reactionary and Secondary—Causes and Treatment.

Torsion, as a means of arresting hæmorrhage, is founded on the observation of the natural hæmostatic process, which prevents bleeding from contused or torn arteries, and to which I have already adverted. The method, as the name implies, consists in imitating the accidental occurrence, by artificially twisting the vessel after it has been drawn out from the surrounding parts. M. Amussat was the first who tried to introduce torsion as a general method to be applied to all arteries divided in operations, and laid down certain principles on which it should be performed. A very obvious objection to the method was, that in drawing out the artery from the surrounding tissues, and twisting it so as to rupture its inner coats, the tractile and twisting force employed was likely to separate the vascular connections of the artery with its sheath, consequently to impair its vitality, and lead to sloughing and secondary hæmorrhage. To obviate this risk, M. Amussat used two pairs of forceps—one pair with sharply grooved points to seize and twist the vessel, whilst with other forceps, which had flat smooth blades, he fixed the artery close to the soft parts, so as to prevent the act of torsion affecting the vessel beyond. The effect produced by this plan is not always exactly the same, but, as a general rule, the two internal coats are ruptured, and more or less inverted, so as to project into the canal of the vessel, whilst the external coat is twisted so as to form a mechanical obstacle to the escape of blood, as represented in Figures 4 and 5, Plate xxiii. Figure 6 of the same Plate represents a very good example of

natural torsion of the brachial artery from a case of injury by machinery, in which I amputated at the shoulder-joint.

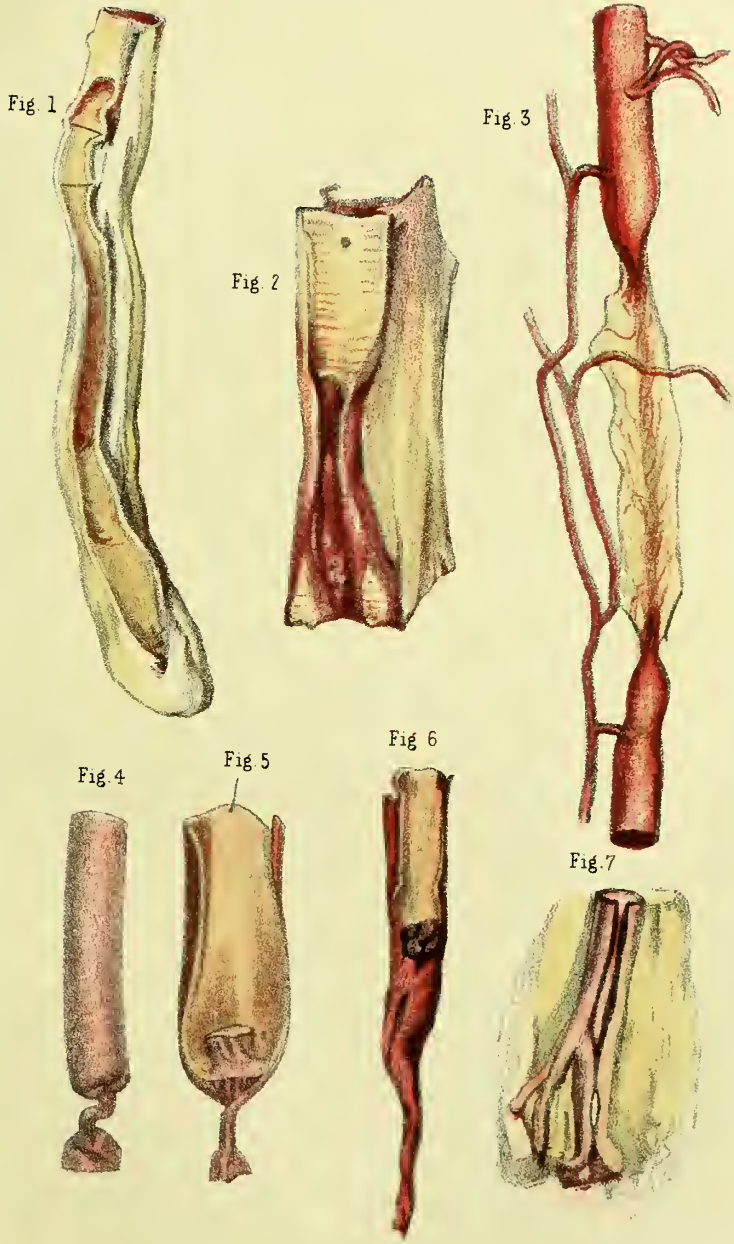
Torsion has recently been revived, and attempted to be re-introduced, as a substitute for the ligature or acupressure. It answers well enough for small vessels, and I frequently use it. Past experience, however, has shown that we cannot safely trust to it in the larger arteries. In the present day the twisting is continued till the twisted portion comes off. This is done to avoid leaving that portion in the wound, as it is almost certain to die and act as a foreign body, or, what is worse, to serve as a centre of unhealthy action. But were this done in the larger vessels, the condition of the inner coats is too uncertain to trust to for arrestment of bleeding. Torsion answers well enough in some cases, and may occasionally be used with advantage; but, as a general plan, it is far inferior either to the ligature or acupressure.

The most recent mode of effecting the occlusion of arteries and the arrestment of hæmorrhage, is that devised by my esteemed colleague, Sir James Simpson, and followed out by him with his usual energy and ability. I allude to the method of acupressure.

Acupressure aims at securing the mouths of the divided and bleeding artery by thrusting a needle through the tissues across the course of an artery, under or over it as the case may be, so that, whilst the needle presses on one side, the resisting tissues on the opposite side exercise counter-pressure. Or direct firm counter-pressure may be made by means of a looped wire passed over the point of the needle, across the course of the vessel, then bent round the needle, and twisted so as to lie parallel to it. The advantages claimed for it are numerous. It is elegant, expeditious, cleanly, and efficient. The needle can be easily introduced and readily withdrawn. It need not therefore lodge in the tissues so long as to produce irritation in them. A strong point in the case, and one of which Sir James has evidently taken advantage, is that the tissues have a far greater tolerance of metallic than of organic substances, however well the latter may be protected by antiseptic or other agencies. One thing is cer-

Plate XXIII

HÆMOSTATICS



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tain, that if the hæmostatic mechanism, of whatever kind it is, can with safety be withdrawn within twenty-four, forty-eight, or seventy-two hours, a great source of anxiety will be got rid of, and the result will be speedy compared with the slow process by which the ligature ulcerates its way towards final separation.

There are seven or eight prescribed methods of applying acupressure, some four of which are usually practised. Three of these are modifications of the direct or Edinburgh mode ; the fourth, and perhaps the most useful for small vessels, is the indirect or Aberdeen twist. The Edinburgh plan is to insert the needle into the tissues, on the near side of the artery, causing its point to emerge close to the side of the vessel, then to re-insert it into the tissues on the opposite side. This makes it bridge over the artery, and so compress it. Thus, its course is at right angles to the artery, and it runs straight across it. The Aberdeen plan consists in transfixing a small portion of texture by inserting the needle in a line parallel to the artery, then turning it round until it traverses either a quarter or half circle, as the case may be, and reintroducing it firmly into the tissues. Thus compression is effected, partly by direct pressure with the needle on the artery, and partly by the tension and resistance of the twisted tissues.

For fuller details regarding this subject, I cannot do better than refer you to Sir James Simpson's original work on acupressure, or to the recent treatise by Messrs. Pirrie and Keith, Aberdeen.

In my own practice I have not yet used acupressure to such an extent as to enable me to speak authoritatively of its advantages or disadvantages. In arresting bleeding from small vessels after the removal of tumours, it can be used with perfect safety, and with the advantage of easy removal of the needle in a short time ; and in wounded arteries, such as the radial or ulnar, or even the brachial, I would have little hesitation in trusting to it. I have used it with advantage to compress the vessels of the cord in castration, as it not only arrests the bleeding, both temporarily and definitely, but also effectually prevents all risk of

the cord or vessels of the cord being retracted within the canal; a risk, however, which is much more imaginary than real. I have also used it in amputations at the ankle; and on three occasions advantageously, to compress the facial below the lower jaw, in cases of removal of tumours of the upper jaw. In the greater amputations I have not tried it, partly because I have found the ligature answer very well, and I am by no means satisfied of the evils said to be induced by it, but chiefly because my experience of the gradual manner in which the hæmostatic process is effected after ligature of an artery, and a consideration of the unfortunate results which followed the attempts of Travers and others to remove the ligature at the expiry of twenty-four or forty-eight hours, have prevented me feeling that confidence which I should desire to have against the risk of hæmorrhage occurring from a large artery on withdrawing the needle at a very early period. At the same time there are some points of difference. The withdrawal of the needle is effected much more easily and with less disturbance of parts than that of a ligature could be. The hæmostatic process would likewise seem to be somewhat different. In a specimen of the brachial artery, for which I am indebted to the politeness of Mr. Lawson Tait of Wakefield, amputation of the arm had been performed under very unfavourable circumstances. Mr. Tait used acupressure by the needle and looped wire method; the man sank in thirty-eight hours after the operation. On examining the portion of artery sent me, and which is represented in Plate xxiii. Fig. 7, I found a delicate blood-clot slightly adherent to the arterial wall. This, however, as might have been expected, was not resistent enough to have prevented hæmorrhage; but at the point of acupressure, and for a short distance on either side, the vessel was firmly occluded by plastic lymph, and there seemed no division of the inner coats of the artery. In ligature, no plastic material is thrown out at the point of deligation, *i.e.* immediately under the constricting ligature; the plastic process takes place on either side of the ligature, or in an artery divided, as in amputation, immediately above the point of constriction. So far as I can judge from this

specimen, the vitality of the part even directly compressed does not necessarily suffer, and consequently plastic changes go on there, and a continuous lymph-plug seems to be rapidly formed and organised. I think, however, that it would be very desirable to have experiments performed, so that the principle of the hæmostatic process, as effected by acupressure, and the differences between its action and that of the ligature, might be thoroughly investigated, as otherwise, notwithstanding the success which seems to have attended its use by some, there must always remain lurking in the minds of surgeons doubts as to the risks of hæmorrhage and a want of confidence which will prevent its general use.

When employed, instead of the ligature, in the case of a continuous artery, as in an aneurism, I must say that I consider acupressure unsuitable, because, when the vessel is deeply seated, the needle would require to be not an ordinary acupressure-needle, but one with a curve, and it is excessively difficult, almost impossible, to withdraw such a needle from a deeply-placed artery, such as the carotid, subclavian, or innominate, without great disturbance of parts.

These difficulties, as regards its application to deep-seated continuous arteries, I have tested on the dead subject, and they would be still greater in the living body.

As to my own practice, I have already said that I do not consider the benefits of acupressure so decided as to lead me to adopt it, as a general method, as a substitute for the ligature.

The Wire-compress, a modification of acupressure, has been used, and with some success, even in securing the carotid artery. It consists in passing a wire instead of a thread under the artery. The ends of the wire are brought up, and the wound is closed. On the surface of the wound a piece of cork is placed, and the ends of the wire are tied over the cork, so as to make it press downwards towards the deeper parts. The wire is tightened till the circulation is completely stopped, and the cork is then fastened down with strips of plaster. This plan seems to have answered very well in some cases, and I once entertained great

hopes of its success ; but there are dangers connected with it. It does not always prevent suppuration, even after the wire has been withdrawn, for abscesses sometimes form where the wire had been, and I have known secondary hæmorrhage occur, and therefore I still think that the small round ligature is preferable to acupressure or the wire-compress in arresting the flow of blood, at all events through a continuous artery.

CONSECUTIVE HÆMORRHAGE arises in two forms, *Reactionary* and *Secondary*. The term SECONDARY HÆMORRHAGE is used to denote the bleeding which sometimes supervenes from the failure of hæmostatic measures, as when it occurs from rapid ulceration of the artery after ligature, before the hæmostatic process has been completed. It is also applied by some to the bleeding which occurs some hours after an operation, from vessels which had not been secured. I think it is better to distinguish the latter form of bleeding by the term REACTIONARY Hæmorrhage as implying its cause, in contradistinction to the various conditions which lead to secondary hæmorrhage proper.

REACTIONARY HÆMORRHAGE arises from small vessels, which, owing to the depressed state of the circulation during and immediately after an operation, do not bleed at the time, and consequently are left unsecured because unperceived. So soon, however, as reaction sets in, and the circulation becomes excited, bleeding from these branches begins. The wound becomes distended with coagula, which tend to keep up the bleeding, and this, unless interfered with, may lead to serious results. In this form of hæmorrhage the knowledge of the cause indicates the proper treatment—namely, to open the wound, clear out coagula, and sponge the surface with warm water, so as to detect and secure the bleeding vessels. In many cases when the clots have been removed, and the cut surface exposed, no bleeding vessels can be seen, the oozing of blood gradually ceases, and nothing more requires to be done. It is not, however, safe to trust altogether to this temporary cessation of the bleeding, for that may be the result of the depression induced by

loss of blood, and the hæmorrhage might recommence when reaction again took place. The proper plan under such circumstances is to give the patient some slight stimulant to rouse the force of the circulation, apply a sponge wrung out of warm water to the bleeding surface, cover up the patient with the bedclothes, and wait for a short time to see whether any further bleeding occurs. If it does, the vessel or vessels can then be seen and secured; if not, the wound is left open so as to prevent coagula collecting, and an assistant should be left for a few hours to watch until the cut surface becomes glazed and dry, then the wound may be finally closed without risk of further bleeding.

The causes of true SECONDARY HÆMORRHAGE have been already in a great measure discussed. They are of two kinds: *First,* those which to a certain extent are preventable by care on the part of the surgeon, and by proper treatment. *Second,* those which are unavoidable, when unfavourable local or constitutional conditions are present. In tying an artery I have shown you that certain points are to be attended to which are of great importance. It is not merely the cutting down upon the artery to expose it that is important; we should endeavour to disturb the connections of the vessel as little as possible. We have seen that the coats of the artery are nourished chiefly by the vasa vasorum, which connect the coats of the vessel to the cellular sheath surrounding it; and if we disturb these very much, either by traction on the vessel, or by too much force in introducing the needle, or by dissecting and insulating the artery too much, we do harm. We should only separate the vessel from its sheath so far as to allow the aneurism-needle to be passed easily round it; but in doing this no force should be used, and the needle should be passed close to the coats of the artery. By paying attention to these details, the surgeon does all he can to prevent secondary hæmorrhage, the great point being to disturb the vessel as little as possible.

The second class of cases are those in which the prevention of secondary hæmorrhage is not so directly under our control.

Such, for example, as those depending on the state of the patient's health, or that of the arterial texture; conditions which have a great tendency to produce secondary hæmorrhage. In some cases, as after amputation—more especially after primary amputation—secondary hæmorrhage may take place from sloughing of the surrounding textures, leading to ulceration of the vessel even above the ligatured point. Again, in a very large number of cases, where secondary hæmorrhage does occur after amputation, it is associated with pyæmia, or some blood-disease, as in cases of malignant growths, circumstances under which all the plastic changes are more or less interfered with; these unfavourable conditions can not be obviated by the surgeon. All that we can do here to prevent secondary hæmorrhage is to use great care in the application of the ligature, and to attend afterwards to the nutrition of the patient, giving nourishing but not stimulating diet, and avoiding for some time after the operation anything likely to over-stimulate the circulation. Antimonials and low diet used to be prescribed to diminish the force of the circulation; but, for reasons I have already adduced, I think this a bad plan, as it tends to prevent healthy plastic changes going on. The best treatment is to keep the patient perfectly quiet, give nourishing diet, and apply only very light or antiseptic dressings to the wound.

The treatment of secondary hæmorrhage will depend in some measure on the nature of the case in which it occurs, and the state of the vessel and surrounding parts. When it arises after wounds, or such operations as amputations, resections, or removal of tumours, if the bleeding be not very profuse, the clearing out of coagula and properly applied compression, or the application of cold, may prove sufficient to arrest it. But if the condition be urgent, either from the rapid loss of blood indicating that its source is some large vessel, or from the debilitated state of the patient rendering loss even of a small quantity of blood dangerous, then no time should be lost in taking decided measures. The stump or wound should be opened after the main vessel has been compressed higher up,

and all coagula cleared out, so that we may see what vessel is the source of hæmorrhage. This appears to me the only safe plan; all temporising measures are dangerous. In cases of amputation it used to be advised to tie the main trunk higher in the limb without opening up the stump. In some few cases this may be necessary, owing to the state of the stump; but direct ligature or acupressure of the affected vessel is generally the safest. Besides, we cannot be quite sure whether the main artery or arteries are the sources of the bleeding.

I recollect, several years ago, being called to the hospital, in consequence of the occurrence of secondary hæmorrhage from the stump of a thigh which was nearly healed, and from which the ligatures had separated some time previously without any bleeding. I was unwilling to open up the recently united parts; and, as the bleeding had been rapid, I concluded it must be from the femoral, and thought it would be better to tie the femoral in Scarpa's triangle. On second thoughts, however, I determined to open up the stump. There was no bleeding from the position of the femoral, but there was a very minute portion of the femur necrosed and separated. The surrounding periosteum was thick and vascular, and one large periosteal artery, opened by the ulcerative process, was seen pumping out blood freely, although the femoral was compressed in the thigh. No other vessel required ligature; the small scale of bone was removed, and the stump healed very rapidly. In this case, the proposed operation was not only unnecessary, but had I tied the femoral high up, I doubt if it would have effectually arrested the bleeding from the periosteal vessel. Recently, in another private case, in which I had amputated the thigh high up, for a malignant vascular tumour of the condyle, secondary bleeding, to an alarming extent, took place about the tenth day. The bleeding was promptly arrested by the patient's medical attendant, who lived near him. On visiting him I found him blanched and faint, and the state of the bed-clothes showed that the loss of blood had been serious. A tourniquet was applied, the stump opened, the clots cleared out, and the surfaces sponged with

warm water, but no bleeding point could be observed. The ligature had separated from the femoral artery, but there was no clot at that part of the stump ; and when the tourniquet was slackened, the artery could be felt and seen pulsating, but not a drop of blood escaped there. Stimulants were given to excite the force of the circulation, but still no source of the hæmorrhage could be detected, and, after waiting for some time, I closed the stump and applied a bandage. No further bleeding or oozing occurred, and the patient made a good recovery. What the cause of bleeding may have been I cannot conjecture, unless it were from the medullary canal of the femur ; but the absence of any indication of the source of the hæmorrhage made me all the more anxious about the case. In cases where you find that the bleeding proceeds from one of the larger vessels in a stump or operation wound, the best plan is to clear the artery higher up, and tie it at a healthy part. In cases where the coats of the vessel are in a doubtful state, or the surface of the wound in its vicinity unhealthy, acupressure by the long needle and looped wire, applied across the course of the vessel higher up, should be tried, in preference to much dissection of the parts, or before we tie the main trunk higher up in the limb.

In cases of secondary bleeding from small vessels—as after excision of tumours—acupressure, or compression, or touching the bleeding point with perchloride of iron, solution of chloride of zinc, or spirit of turpentine, is generally sufficient for the purpose of stopping it.

When secondary hæmorrhage follows ligature of a continuous artery—as in cases of deligation for aneurism—it is very serious, and our measures must be prompt. Compression should be made on the trunk of the artery nearer the heart, to command the bleeding, the wound opened out, clots removed, and the artery cleared and tied above and below the ulcerated point. This is absolutely necessary in the first instance. Whether we may require to tie the vessel, at different parts of its course, much nearer the heart, will depend on circumstances, such as, the state of the vessel—that being so altered as not to be

likely to withstand the action of the ligature till permanent hæmostatic changes have occurred—or the soft parts around the vessel being so injured that sloughing and recurrence of bleeding are likely to take place. I have already alluded to a case of ligature of the axillary for bleeding from the brachial in a burn of the arm. This example will be found in the Clinical Cases* appended to this section. In all cases, the bleeding point must be secured above and below by ligatures or needles.

In some cases, from peculiar circumstances, amputation may become imperative. We must not, however, proceed to heroic measures too hurriedly. I have known slight bleeding occur in a case of ligature of the femoral some days after the ligature had separated, in which, by leaving the wound exposed without compression, the hæmorrhage ceased, and never recurred (see Clinical Cases). In cases where arteries are opened into by diseased action of the neighbouring textures, it is often impossible to detect the bleeding point, even though we may suspect it. In these cases we must trust to pressure, or, if that cannot be borne, then we must tie the arterial trunk higher up. This may suffice ; but it may fail, as in the case of Mr. A. T., recorded in the Clinical Cases.

* Page 594.

LECTURE LXIX.

Diseases of Arteries—Arteritis—Fatty, Calcareous, and Waxy Degenerations: Processes and Laws by which they conduce to Lesions of the Bloodvessels—Aneurism: True and False; Definition and Classification—Varieties of Aneurism: Dissecting, Fusiform, and Sacculated Forms; their Physiological and Pathological Tendencies and Terminations.

As I have now described at some length the injuries of arteries, and natural and artificial hæmostatics, I proceed to bring before you the diseases of the arterial system and their treatment.

Acute arteritis is a disease, the existence of which is still problematical. In the neighbourhood of wounds, or other sources of irritation, limited portions of the arterial walls may present the usual appearances of inflammatory action, such as depositions of pus or plastic lymph within their tissues; but, as to the existence of general or extensive inflammation of the arterial coats, arising from ordinary idiopathic or constitutional causes, pathologists are not yet agreed. There is the same doubt regarding the existence of any general chronic arteritis of a simple nature, though it is becoming more and more probable that irritative action, partaking somewhat of the inflammatory character, is closely connected with the production of certain of those degenerative changes, the evidences of which are found so commonly in the walls of arteries on *post-mortem* examination.

These degenerations, which are important to the surgeon as well as the physician, are three in number—namely, the fatty, the calcareous, and the waxy,—the first two being closely connected in their nature and mode of origin. We need say little about the waxy, as it comes more especially within the province of the physician. It is a disease very frequently found in association with the syphilitic or other wasting dyscrasiæ,

affecting not only the whole of the vascular system, but also the various organs of the body, more especially the liver and kidneys. It produces a thickening, and consequent diminution of elasticity, in the walls of the vessels; and, when attacking the liver or kidneys, its advanced stage is marked by the deposition within the cells and intervascular spaces of a homogeneous substance, the accumulation of which enlarges the organ, and gives its section a semi-translucent waxy or lardaceous appearance, from which the disease has derived its various names.

The fatty and calcareous degenerations are essentially diseases of advanced life, their traces being found almost universally in greater or less degree within the arterial walls of old people after death. They are, however, met with very frequently in middle life, and they may be noted from time to time even in the comparatively young. The *post-mortem* appearances of an artery which has undergone this form of degeneration are very characteristic. Its coats have a thickened, leathery appearance, due to degenerative changes having occurred more or less throughout all its tissues; and, if the vessel be slit open, well-marked patches, of varying size, and of a greyish-yellow colour, will be found scattered over its inner surface. These are called atheromata. They are depôts of fatty *debris,* the product of degeneration, collected under the inner serous lining of the vessel; and if one of them be cut open, its cheesy contents will be found, with the aid of the microscope, to consist of a great quantity of fatty molecules, intermixed with scales of cholesterine, and a varying number of granular masses, composed of the carbonate and phosphate of lime, which effervesce on the addition of an acid. Deposits of pure earthy matter may alternate with the atheromatous patches, and in many cases they are exceedingly marked, whole arteries becoming converted into bony canals, quite devoid of elasticity and much diminished in calibre. The part supplied by such a vessel necessarily suffers in its vitality, and, as was explained when considering that subject, gangrene not unfrequently results, especially the dry form of it known as *gangrena senilis.*

The tendency of an atheromatous deposit is to go on accumulating, until, having reached a certain size, its lining membrane is attacked by a species of ulceration which presently allows the escape of the atheromatous matter into the current of the blood. A cavity is thus formed, which is called an atheromatous ulcer. It may penetrate only through the serous lining, but in the majority of cases it also involves the middle coat, and, in a degree corresponding to its depth, it weakens the wall of the vessel, which at this point becomes very liable to be affected with aneurism.

Prior to the occurrence of calcareous or atheromatous deposit, pathologists now recognise a stage of inflammatory action, more or less chronic in its nature, which is important as regards the causation of the disease, it being precisely in those localities most subject to irritation of various kinds that degeneration of the vessel and aneurism are most likely to occur. For example, in certain cases we find that the atheromatous deposit arises at some point where there is a considerable amount of force affecting the vessel, as at the arch of the aorta, which meets with the first full impulse of the blood coming from the heart. In health, this impulse is met by the resistance of the elastic and muscular coats, but when degeneration has occurred, these ultimately yield from the constant strain upon them. Again, near the bifurcation of a vessel, where it is becoming thinner, and where the blood meets with a slight interruption to its equable flow, we find that there is often a tendency to the production of aneurismal dilatation. Opposite any joint, also, which is much used, as in the popliteal space behind the knee, disease of the arterial trunk is very likely to occur. Thus, before the days of railway travelling, post-boys used to be very frequent subjects of popliteal aneurism, and now this form of disease is chiefly met with in persons who, from their occupation, constantly employ the knee-joint. For the same reason, all athletic exercises, if excessively indulged in, have a like tendency. After a certain period of life—say about forty or fifty years of age—if an individual continue to addict himself to

such pursuits with the same ardour as in his youth, his muscular force being perhaps as strong as ever, he is not unlikely to have an aneurism, because the arterial coats may have been slowly degenerating with advancing years, so as to be now unable to resist the additional strain put upon them by the muscular exercise. Mr. Liston long ago drew special attention to this fact, and his own case unfortunately illustrated too well the truth of his observations. There are other conditions, such as dissipated habits, which lead to arterial disease and the formation of aneurisms; and the existence of the syphilitic cachexia is thought by many authorities to act very powerfully as a predisposing cause.

An Aneurism may be defined as a tumour containing fluid or coagulated blood, situated upon an artery and communicating directly with its canal. Pulsation is a symptom almost invariably present. A sanguineous swelling, such as a thrombus, though it may be situated on an artery, is not an aneurism, because its cavity does not communicate with the canal of the artery. The above definition includes all forms of aneurism, both true and false. Under the head of *True Aneurism* I would class all *aneurisms arising from disease* of the arterial texture, whether the diseased condition be a degeneration and dilatation of all the coats of the vessel, or an ulceration of one or more of them, leading to dilatation of the external or fibrous coat. The existence of arterial disease is the essential character of a true aneurism as distinguished from a false; and it is that which indicates the great practical difference in the mode of treatment. The circumscription of the aneurism by a sac derived from one or more of the arterial coats is another character of true aneurism always present in its earlier stages, but it is not so important in a practical point of view as the diseased condition of the coats of the vessel.

A False Aneurism is nothing more or less than a wounded artery, the blood, prevented from escaping externally, being coagulated in the cellular tissue, which becomes condensed, and forms a sort of cyst, though generally a very imperfect one, as

in some cases the force of the blood-current dissects the textures widely. The wound in the artery remains open, and enlarges by degrees, so that pulsation is in this case also a marked feature of the tumour. The coats of the vessel in this instance may be perfectly healthy, and accordingly we can treat it just as we would a wounded artery—namely, by laying open the sac, and tying the vessel above and below the wounded point. A diffuse aneurism resulting from rupture of a true aneurismal sac should be regarded as the last stage of a true, and not be classified as a false aneurism.

There are several varieties of true aneurism. All, with one exception, tend to produce well-marked, rounded tumours, the exception being the form called "*The Dissecting Aneurism*," in which, though there is some amount of swelling in the course of the vessel at the point affected, we can scarcely say it is sufficient to constitute a tumour. From rupture of the circular muscular fibres of the arterial coat, or from the atheromatous and calcareous ulceration already alluded to, the blood in this variety escapes outwards, and burrows beneath the external coat, separating it from the middle, so as to form a cavity, which may extend for a considerable distance in the course of the vessel, and involve more or less of its circumference. This is, however, a form rarely met with except in the aorta. I have seen only one instance of it elsewhere—namely, in the common iliac artery (Plate xxiv. Fig. 5). The direction of the burrowing action is generally from above downwards—that is, towards the extremities—though it may occasionally proceed in an upward direction, or towards the heart, as in the case of the common iliac artery just alluded to, where its downward course was obstructed.

The ordinary True Aneurisms may be divided into two classes—

(*a*) The Fusiform (Scarpa's True Aneurism), in which we find dilatation of all the coats of the artery, arising from fatty disease of one or more of them—generally of them all.

(*b*) The Lateral or Sacculated True Aneurism, where there is ulceration of the middle and internal coats of the vessel, and

Plate XXIV

ANEURISM.

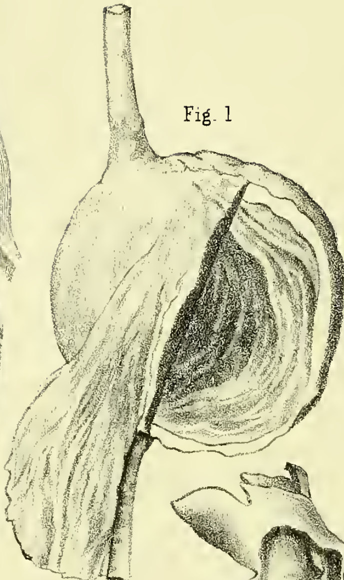

Fig. 1

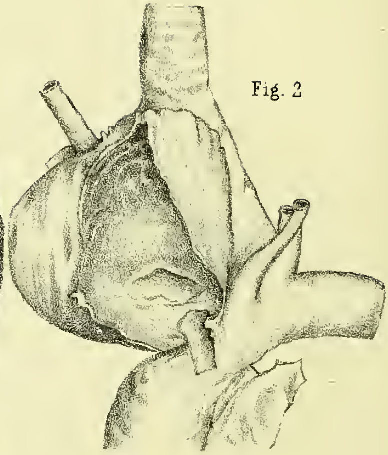

Fig. 2

Fig. 5

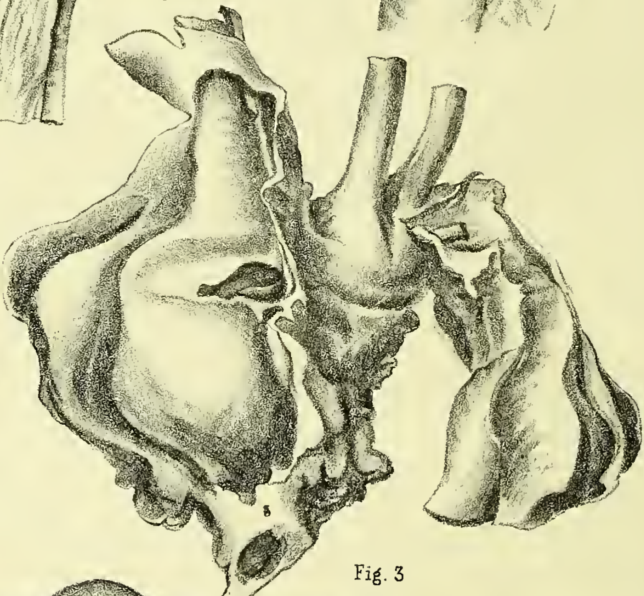

Fig. 3

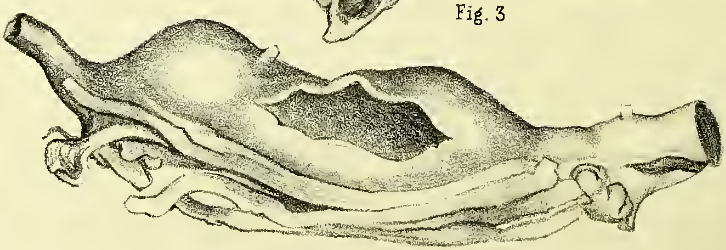

Fig. 4

Waterston & Son Edin Lith

gradual dilatation and bulging of the external fibro-cellular coat.

In the Fusiform Variety the diseased condition of the artery is that of general fatty degeneration, which soon causes it to lose its elasticity and power of reacting upon and propelling the blood. It therefore gives way before the pressure of its contents, and at the weakest part a dilatation takes place, which gradually assumes an ovoid or fusiform shape. By-and-by the internal lining coat of the artery becomes roughened by little masses of atheromatous and calcareous deposit, which form beneath it, and in course of time give a coarse granular appearance to the interior of the sac. This is generally a very unfavourable form of aneurism, for there is in most cases the same diseased condition which produced it existing throughout the whole arterial system, though to a less extent than in the particular artery affected. The following points are important as characteristic of this variety ;—the vessel dilates with comparative slowness ; the aneurism is, as a rule, easily emptied of its contents by pressure ; the pulsation is very distinct and very equal ; and there is present in it a *bruit* of a peculiar kind, different from that heard in other varieties ; the vessel above and below the dilated point is generally thickened, but is still able to react upon the blood passing through it ; the lining membrane is in the first instance smooth, and the tendency of the blood to coagulate on its surface is small, for the cavity is not very much dilated, and the current of blood passes through it in a direct and continuous stream.

In the Lateral or Sacculated True Aneurism we have ulceration of the two internal coats of the artery, and gradual dilatation of the outer or fibro-cellular coat. This aneurism generally arises from some atheromatous or earthy deposit taking place between the internal and middle coats of the vessel, which leads to irritation of the part, and ultimately, as already described, to ulceration. Probably the increased amount of friction from the current of blood to which the atheromatous patch is exposed may be one of the causes leading to ulceration of its lining

membrane, for the inner coat of the vessel is raised and roughened by the atheromatous deposit, and the blood rushing continually over such a surface will naturally produce some degree of irritation. In this aneurism the vessel does not dilate in its whole circumference equally as in the ovoid variety, but it slowly projects the external coat at the seat of the atheromatous ulcer till it forms a round or sometimes ovoid-looking swelling upon the *side* of the vessel. It may grow to a great size—the opening of communication with the vessel slowly increasing with the growth of the sac.

These are the forms of true aneurism, and in each of them it will be observed that the two essential characters are present, namely, a diseased state of the arterial texture, and a sac formed by the dilatation of one or more of the arterial coats.

There are certain *tendencies* in true aneurism which must be noticed, as they serve as indications in the treatment of the disease. Of the greatest importance is the tendency to coagulation within the sac. This varies in intensity according to the degree of stagnation, being greatest in the saccular form, where the cavity of the sac is, as it were, withdrawn from the vascular current, and, for the opposite reason, least in the fusiform. As the coagulation advances, changes take place in the collateral circulation. The presence of an aneurism, even though there be a free channel through it for the blood, is always a cause of more or less retardation to the local circulation, the normal resiliency of the vascular walls being lost at the seat of disease. Meeting with such an obstruction, the blood is more and more diverted into the collateral branches which arise from the main trunk on the proximal side of the aneurism, and these, to meet the exigency, become slowly and gradually enlarged. These two processes,—coagulation within the sac, and gradual diversion of the current of blood to the collateral circulation,—may steadily proceed until the blood pass so slowly through the sac as to allow of complete coagulation, and a spontaneous cure. In the fusiform aneurism this is not readily effected, owing to the smoothness of the lining membrane, and the com-

paratively equal dilatation of the vessel, the blood sweeping off any coagulum from the walls of the sac; but as the lining membrane becomes irregular from the deposition of atheromatous matter, and assumes the granular appearance formerly alluded to, the blood-particles tend to become arrested, partly on this account, and partly owing to the diminishing force of the blood-current brought about by the establishment of the collateral circulation.

In the saccular or lateral true aneurism, the different steps of the process are very well illustrated, and the tendency towards a successful issue is much more considerable than in the fusiform variety. Here, from the greater irregularity of the internal surface of the sac, particles of fibrine readily attach themselves, so as to form a clot; the determination of the blood to the collateral branches is also well marked; and, as the sac increases in size, its cavity is more and more removed from the influence of the current in the artery, so that a degree of stagnation ensues, which is extremely favourable to the occurrence of coagulation. This, in the first instance, takes place at the parts of the sac most distant from the circulation, and it goes on until a large mass of clot has accumulated. After a time the colouring matter of the clot becomes absorbed, and at last we find the sac of the aneurism filled with a mass of decolorised coagulum arranged in strata, and partly connected with the lining membrane by means of an exudation of plastic lymph. The natural cure is thus all but completed, and it would be completed in many cases were it not that the continual agitation of the blood at the mouth of the sac prevents entire coagulation, and by-and-by tends to undo the work which has been accomplished. It breaks down the clots already formed, and once more exposes the sac to dilatation and enlargement, which may steadily proceed until rupture takes place—a result the more likely to occur if the force of the blood in the sac be not greatly abated by the establishment of the collateral circulation.

In the fusiform aneurism, as has been already remarked, these changes take place less perfectly, and it may be added

that the risk of a return of the disease after the collateral circulation is established is more to be apprehended in such a case.

Important indications for treatment are derived from these tendencies on the part of nature in effecting her cure; but before considering the treatment let us notice the DIAGNOSTIC SYMPTOMS of the disease, as these will vary in each variety, and according to its stage of progress. In the first stage an almost invariable symptom of a true aneurism is pulsation, equal in all directions, expansile in character, and synchronous with the heart's action. The tumour also, though tense and elastic, can, by gradual compression, be effaced, its contents being temporarily pressed into the vessel with which it communicates; but on removal of the pressure it fills again with a bound, and pulsates as before. It is affected in like manner by direct pressure on the main trunk higher up, this rendering the sac at once flaccid, and stopping all pulsation in it. There is a peculiar *bruit* audible in most aneurisms. Its presence will depend partly on the form of the sac, and partly on the condition of its contents, as, for instance, to what extent a coagulum may have formed; but one condition, when present, very markedly gives rise to it, namely, a comparatively small opening or neck to the sac; the peculiar rushing sound is then heard very loudly. It often exists in other circumstances, but, as a rule, it is not so marked when the opening is large, for the blood then flows into the sac more smoothly and slowly. In the ovoid or fusiform variety the *bruit* is very peculiar. It is sometimes double, but on the whole it is *sui generis,* and scarcely admits of description. These, then, are the symptoms of aneurism in its first stage, that is, before coagulation has taken place to any extent. The pulsation is equable throughout the sac; there is generally a *bruit* present; and the tumour is capable of being obliterated by pressure.

In the second stage, after coagulation has occurred, the symptoms are modified. The pulsation is still full and expansile, but not now equally forcible at all points, for in the greater part of its extent the sac is filled with coagulum, and thus protected from the force of the blood, which can only act strongly upon

those parts where little or no clot exists. This fact accounts for the inequality of the pulsation as felt externally. Again, we can no longer efface the tumour by pressure, nor can we make it completely flaccid by compressing the main trunk, for both these processes are interfered with by the presence of the coagulum. In this stage certain local symptoms, which vary in their nature according to the seat of the disease, are complained of by the patient. The tumour, as it is now nearly in the condition of a solid mass, gives rise to symptoms which did not exist in the same degree when its contents were still fluid. In carotid aneurism, for example, there may be symptoms of spasmodic or constant difficulty of breathing from pressure on the upper part of the trachea, and in popliteal aneurism, intense pain may be felt in the limb from pressure on the popliteal nerve, though this may be present to a less extent even when the contents of the sac are fluid. As the disease advances, the tumour may press upon the larger veins, and œdema of the limb will be the result. In the upper extremity, especially, this symptom is of very frequent occurrence. Again, if the tumour attain to a very large size it may lead to gangrene of the limb, from the pressure on the veins and on the collateral branches causing the circulation to be almost completely arrested. Lastly, by the constant pressure which it exercises upon all surrounding parts, it will alter and condense the soft texture, and eat out, by corrosion, any bony surface with which it may come into contact.

An aneurism, if allowed to go on without treatment, may terminate in various ways. It may rupture, causing effusion of blood and coagula into the tissues of the limb, and some have called such a case a false aneurism, but this leads to confusion, and it is therefore better to consider it as a true aneurism which has become diffuse in the last stage. Rupture, again, may occur through the skin, or into one of the internal cavities, causing the sudden death of the patient; and, lastly, the sac may not rupture, but go on enlarging until it attains an enormous size, the blood of the patient being more and more withdrawn into it from the circulation, so that he may finally become exhausted by

anæmia and constant pain, and die by a gradual asthenia. This, however, rather applies to the cases which come under the care of the physician.

In certain cases of febrile disease we occasionally meet with acute ulceration of all the coats of an artery at some one point, without any appearance of the usual atheromatous or other deposit, and in such cases the blood is directly effused into the cellular tissue of the neighbourhood, where it forms a diffuse aneurismal swelling. This, however, is very rare. The preparation I now show you is such an aneurism of the carotid, which occurred in a patient recovering from typhus fever.

LECTURE LXX.

Treatment of Aneurism: Historical Sketch of the views formerly held regarding it—Hunter's Principles, and the Modifications which have resulted from them—Brasdor's Method—Risks and Contingencies attending the various Plans of Treatment—Precautions necessary to meet these—Ultimate Resource: Amputation.

Formerly, when the circulation was not understood, and when the pathology and tendencies of the disease were less known, the treatment was without any fixed principle. One of the earliest methods consisted in applying direct pressure upon the tumour, with the view of preventing its growth, and finally obliterating it if possible. When this failed to effect a cure, the surgeon laid open the sac, turned out its contents, and tied the vessel above and below, just as is done now-a-days in cases of false aneurism. This, however, was found not to be a very successful mode of procedure, for the diseased and friable condition of the artery at the seat of the ligature often rendered its application difficult, and, in the subsequent process of its separation, secondary hæmorrhage was very apt to ensue. Surgeons, therefore, wisely devoted their attention to the methods by which nature effected her cure. In the medical treatment of aneurism, Valsalva first recognised this natural tendency, and in a certain degree followed out its indications. To diminish the force and frequency of the circulation, he had recourse to frequent depletion, and also the use of antimony and other depressants. The patient was kept perfectly quiet, and his supply of nourishment was gradually reduced to the minimum necessary to support life. These extreme depressing measures, however, were soon given up as ineffectual,—indeed, when carried beyond a certain point, the principle was erroneous. To obtain in the natural process of cure a firm coagulum, a certain amount of blood should be

constantly supplied to the sac in order to furnish it with the necessary fibrine, and in the subsequent absorptive processes there is the effusion of lymph or plastic material ; but in Valsalva's plan the whole treatment consisted in the diminution of the mechanical force of the blood, and the chances of firm coagulation in the sac were diminished from the want of plastic and fibrinous material. The next plan of treatment was that of Hunter, who still further carried out the indications of the natural process of cure. He saw that what was wanted was the diminution of the force of the blood-current, not its complete arrestment ; also that the blood might enter the aneurism by the collateral branches, and yet not interfere with the process of coagulation, rather, in fact, promote it by continually depositing fresh fibrine. Hunter saw also that he could best accomplish his object by tying the vessel at some little distance from the aneurism, as this would give him a better chance of finding the coats of the artery in a healthy condition. He accordingly tied the femoral artery for popliteal aneurism at the part of its course where it lies encased between the tendons of the thigh in a sort of tube, called afterwards, in honour of him, Hunter's canal—the ligature being placed upon the artery at a point above the origin of the anastomotica magna branch. The great success of this mode of treatment soon established the soundness of Hunter's principle, which continues to hold its ground in the present day, although in the case of popliteal aneurism another locality has been selected as the seat of the ligature—namely, the lower angle of Scarpa's triangle ; for the operation, while quite as effectual, is much more easily performed in this locality, and the ligature is applied further away from the disease, and from the large anastomosing branches given off lower down. The principle consists in tying the artery at some little distance from the aneurism, where we are likely to find the coats of the vessel in a healthy state. We thus prevent the direct influx of blood into the sac, and divert the current into the collateral branches, allowing coagulation to take place, layer after layer, until at last the tumour is converted into a perfectly solid mass.

It then gradually diminishes in size, and becomes finally reduced by the process of absorption.

The same principle has, since Hunter's time, been carried out by other means than the ligature, for example by simple Compression. In the treatment by compression, pressure is applied upon the affected vessel on the proximal side of the aneurism,—on the superficial femoral, for example, in cases of popliteal aneurism.

This is effected either by pressure by the fingers of relays of intelligent assistants, who relieve each other at intervals, or by means of special apparatus, with which we exercise a graduated compression on the vessel at some distance on the cardiac side of the aneurism. The nature, forms, and mode of applying the different apparatus, will be better understood by looking at the plate than by any description. Compression slows or diminishes the force of the current of blood, and throws it upon the collateral branches, but not so abruptly as when the ligature is used, for the artery is rarely if ever occluded at the compressed point. The compression is continued until the coagulation has converted the tumour into a solid mass in the manner already described. The objections to this method seem to me to be that very few patients can bear the compression, and that it is also by no means so certain as ligature of the vessel, which operation is often required after the compression has been used for some time.

Another method of slowing the current of blood through the sac is by *flexion*, which may be advantageously used along with compression. In popliteal aneurism, if we firmly flex the knee-joint, we find that the pulsation ceases. We have stopped the flow of blood into the tumour by the flexion of the vessel on which it is situated. It must, of course, be done gently, and by gradually flexing the leg upon the thigh, and the thigh upon the pelvis, otherwise the patient will not be able to bear it. By the acute curves or flexures of the vessel, which we effect by this position, we are enabled to slow the blood-current, and to cause coagulation and consolidation of the contents of the sac. The apparatus required is very simple, and is similar to that used for the treatment of ruptured tendo Achillis. I have seen this method

prove effectual in a case, the circumstances of which were peculiar. I had tied the femoral artery, and this had apparently cured the aneurism, but about eighteen months afterwards the tumour began to return very rapidly, and I then tried the treatment by flexion alone. This quite stopped the circulation, and the cure was permanent, the aneurism having never returned. It is not always quite safe, however, to trust to flexion alone. In the case of another man who had disease of the aorta and of the heart, and who was not in a favourable condition for tying the femoral artery, I employed flexion, and the aneurism became hard and solid, and was apparently cured in a very short time, but after some injudicious movements of the patient it suddenly gave way and became diffuse. Compression was immediately made upon the artery higher up, so that the diffusion of blood was very limited, and I at once tied the femoral in Scarpa's triangle, but subacute gangrene supervened, and secondary amputation was required. If in this case compression and flexion had been employed conjointly, an effectual cure might have been obtained and the risk avoided. In another case of popliteal aneurism, at present in hospital, I tried flexion and compression together for about six months, but without much effect, for the aneurism was a fusiform one. I then brought him into the hospital, where I tied the femoral, and a successful result has been obtained. Though the principle of all these methods is the same, I must say that I consider ligature of the superficial femoral for popliteal aneurism to be preferable either to flexion or compression. We may try flexion first as a means of preparation for the ligature of the artery, and at the same time employ compression over the vessel in Hunter's canal; but the ligature, if properly applied, is certainly the most effectual.

There is still another method of treatment which seems at first sight to be directly opposed to correct principles,—that is, tying the artery on the distal side of the aneurism, at a healthy point beyond the aneurismal sac. We should suppose that the impulse of the blood on the sac when the current was arrested on its distal side would burst the aneurism, but it is found that on

applying a ligature on the distal side of the tumour, the blood ceases to flow through the sac, though its impulse is communicated to it. We therefore produce a certain amount of stagnation in the sac, and so favour the occurrence of coagulation. This was the method proposed by Brasdor, and revived and modified by the late Mr. Wardrop.

Whatever plan of treatment we may adopt in a case of true aneurism, there are certain risks which must be kept in view. For example, the surgeon knows there is a risk of gangrene, arising from deficient vascular supply, and this condition he must be prepared to avert if possible.

When an artery is tied, the blood is thrown upon the collateral branches, and in the case of a wounded artery the collateral circulation is generally sufficient for nutrition.

In aneurisms, while there are certain conditions which are not so favourable, there are others which favour the collateral circulation. The gradually increasing obstruction to the current of blood passing through the aneurism tends, as was previously explained, to send the blood into the collateral branches, and so to prepare them for carrying on the circulation. In ordinary circumstances we have a very large series of such branches, so that we need seldom fear any want in the collateral circulation. In aneurisms in the head and neck, indeed, there is a risk of the collateral circulation becoming too free, and forming a disturbing influence on the distal side. The immediate effect of deligation of an arterial trunk, however, as a general rule, must always be to weaken the circulation of the parts supplied by it. After the superficial femoral has been tied, there is an enlargement of the descending branches of the perforating arteries, and other vessels from the profunda, together with the branches of the external circumflex artery, which anastomose with the articular branches of the popliteal artery, and with the anastomotica magna; so that there is a free inosculation in and beyond the popliteal portion of the vessel. But when an aneurism exists in the popliteal space, the coagulation generally blocks up some of the articular arteries, so that the number of available

collateral branches is diminished. There is at first, therefore, a risk of deficient circulation, and it is to be remembered that during this state any stimulation of the limb is liable to be followed by a subacute form of gangrene, to avoid which certain points in the after-treatment are to be attended to. After the ligature is applied, the limb should be very slightly bent, so as to relax the artery a little, and it should be wrapped in cotton wadding; but nothing must be applied which could possibly constrict the limb at any point. Lastly, the limb should be placed upon a water-pillow, so that there may be no undue pressure on any part of it, such as might prevent the free carrying on of the collateral circulation. At first the patient complains of coldness in the limb, and it feels colder to the touch than that of the opposite side. This often leads to great mischief, for the nurse may apply hot-bottles to increase its heat, and nothing is more likely to give rise to sloughing or gangrene through over-stimulating a part which is so weak. The limb should be wrapped in cotton wadding, but no artificial heat whatever ought to be applied to it, and it should be kept as quiet as possible. If the patient complain of great pain, an opiate may be given, and the diet in all cases should be moderate, but not stimulating.

Where compression has been used to arrest the circulation, we find, if it be successful, that the enlargement of the collateral branches is principally confined to the immediate neighbourhood of the aneurism. When the superficial femoral has been ligatured, the collateral branches, such as the gluteal, the ischiatic, the great internal and external circumflex arteries, and other branches above as well as below the ligature, become enlarged, and form a chain or network of anastomosing vessels, which carry on the circulation. When the vessel is compressed, its tube, as already said, is not occluded so as entirely to prevent the flow of blood, but only so as to slow its current; and hence the enlargement of the anastomosing branches may be more limited.

We have now to consider certain cases, where neither the ligature, nor compression, nor flexion, is suitable. In some

cases the patient complains of pain in the sac of the aneurism and along the course of the vessels, and there is perhaps some œdema in the neighbourhood. The pain increases at night, and there is a slight redness on the surface of the tumour; the pulse also is quick and irregular from the general disturbance of the circulation. These symptoms indicate inflammation of the aneurismal sac. This condition may terminate in two ways: either by the more rapid coagulation of the blood within the sac, or more generally by partial decomposition of the blood and suppuration. If the suppuration takes place slowly, a natural cure may be effected; but, in many instances, when suppuration occurs, the abscess opens externally, and hæmorrhage comes on. Frequently, also, decomposition takes place, and portions of the broken-up and decomposing clot are carried into the circulation, and gangrene supervenes, or death results from embolism or blood-poisoning. When inflammation has occurred, the surgeon should not think of tying the artery until the excitement in the sac has subsided.

A more frequent condition is that the aneurism increases rather rapidly, and becomes pretty solid, causing pressure on the larger veins and on the collateral circulating branches. From these conditions œdema takes place, the limb assumes a mottled appearance and has a lower temperature than usual, and symptoms of gangrene gradually come on. Sometimes, without the other symptoms, there may be great œdema from the venous obstruction, and from the pressure on the collateral circulation. If these conditions exist with a very large aneurism —say in the popliteal space—the case is unfavourable for ligature. In some cases, by tying the artery above the aneurism, the bulk of the tumour decreases, and an amelioration of the other conditions takes place. But where the symptoms are very much marked, with coldness of the limb, and a mottled appearance of the skin, the case is very unfavourable for ligature of the artery; and if there be any doubt whether a partial diffusion of the aneurism have taken place, the case is one where amputation is preferable to ligature, or any other mode of treatment.

If we tie the artery when the limb is in this condition, the swelling will obstruct the collateral and venous circulation, and such obstruction, superadded to the diminished supply of blood consequent on the ligature of the main trunk, would almost certainly induce gangrene. Therefore, under such circumstances, amputation is preferable to ligature.

A true aneurism may burst and become diffuse, and gangrene of the limb may supervene. In this case also amputation is required. Where the aneurism has burst fairly into the limb, and where the collateral circulation is pressed upon by the mass of blood thus thrown out, there can be no question as to the propriety of amputation. In certain cases of aneurism, however, in the axilla and elsewhere, we may first adopt the method of laying open the tumour, turning out the coagulated blood, and tying the vessel above the opening in the artery, so as to give the patient the chance of saving the limb without incurring much risk; but whenever gangrene is threatened, with coldness and mottling of the limb, then amputation must be performed. Amputation may also be preferred to ligature of certain arteries, such as the innominate, the ligature of which has almost uniformly proved fatal. In one case of aneurism of the second and third parts of the subclavian, where the patient was suffering great pain, the limb being cold, there was no choice but between amputation of the arm and ligature of the innominate artery. In that case I amputated the arm at the shoulder-joint, and tied the artery as near the outer side of the aneurism as possible. The patient went on well so far as regards the amputation; the aneurism diminished in size, and for some weeks a cure seemed to have been effected, but after a little the aneurism began to return in consequence of the irregular conduct of the patient; under proper treatment it afterwards again diminished in size, and it has not since enlarged. It is now about four years since the operation. Though the aneurism never entirely disappeared, it was very much reduced in size, and contained a considerable amount of solid matter. Whilst this case, properly speaking, was not a successful one, still I con-

sider that if the arteria innominata had been tied, a fatal result would soon have taken place. If it had been a case of ordinary lateral aneurism, the cure would probably have been perfect, but the aneurism was a fusiform one, and therefore less amenable to treatment. Under similar circumstances, I would again resort to this plan of treatment, which was just Brasdor's operation of tying the vessel on the distal side of the aneurism, with the addition that we also removed the source of the attraction of the blood to the parts beyond the tumour, and so gave a greater chance of consolidation to the contents of the sac.

LECTURE LXXI.

Traumatic or False Aneurism : Diffuse and Circumscribed ; Nature, Progress and Treatment—Aneurismal Varix : its Definition and Diagnosis—Varicose Aneurism : Symptoms and distinguishing Features—Treatment of the two Conditions founded on the Pathology of each.

A Traumatic or False Aneurism is nothing more or less than that which results from a wounded artery. When a vein is implicated as well as the artery, the symptoms are to a certain extent modified. The most common form is the *Diffuse false aneurism ;* the blood becomes diffused among the tissues, forming a sort of flattened mass over the course of the vessel, which communicates to it a feeling of pulsation. The blood continues to be poured out for some time, so that the effusion is generally considerable, causing the limb to be swollen and painful.

A false aneurism may also be circumscribed. For example, if the wound in the artery be small, and if pretty firm compression be applied at the time, the blood does not escape in large quantity or with great force into the limb, but gradually forms a sort of tumour, the cellular tissue becoming condensed and thickened so as to form a rounded sac, which completely circumscribes the effused blood, like the sac of a true aneurism, and in some parts of the body the anatomical disposition of the surrounding structures assists this limitation.

A circumscribed false aneurism in some degree approaches in character to true aneurism, in so far as the limitation favours consolidation of its contents, when the force of the proximal blood-current is intercepted or diminished.

The treatment which I consider the best in all cases of ordinary false aneurism, whether diffuse or circumscribed, with the exception of certain circumscribed false aneurisms of the

Plate XXV

Fig. 1

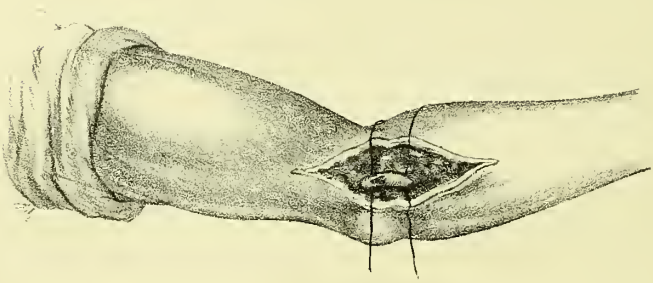

Fig. 2

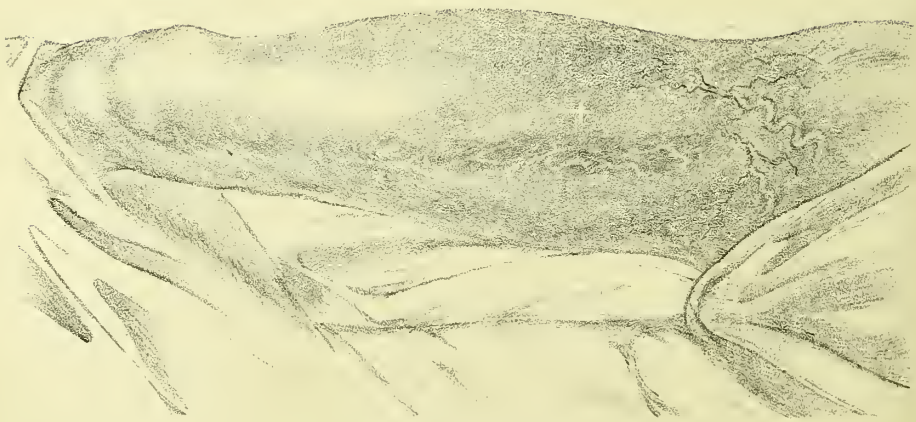

Fig. 3

W. & A.K. Johnston? Warrston & Son Edin Lith

femoral, is to cut down on the tumour, turn out the coagula, and tie the artery above and below the wounded point.

Suppose we are about to operate in a case of false aneurism at the bend of the arm :—A tourniquet is applied at the upper third of the arm to compress the brachial and so command the circulation during the operation, and the care of the tourniquet is confided to an assistant. The arm and forearm are held as straight as possible, and supine. The surgeon then makes a very free incision through the skin and superficial fascia, from above to below the swelling, taking care to avoid the larger superficial veins, or, where that is impossible, to secure them before proceeding further. This first incision must not be made at random ; for though our main objects are to open the sac, turn out the contents, and look for the wounded point, it is nevertheless very important to make the incision correspond to the course of the artery, so as to render the after-part of the operation more easy and certain. If we trust entirely to the cicatrix of the original wound as a guide, that may have been displaced by the swelling, and may not now correspond to the wound of the artery in the deeper part, and hence may mislead the operator. The incision above should be made along the inner edge of the biceps, and then carried down over the tumour with a slight degree of obliquity from above, downwards and outwards. When the first incision is completed, the strong glistening aponeurotic fascia, distended by blood, bulges out, forming a more or less rounded swelling. The operator makes an incision into this at the point which seems likely to correspond to the wound of the vessel, introduces his forefinger, and then with a probe-pointed bistoury enlarges the incision upwards and downwards to the full extent of the false sac, and turns out the coagula.

This method of opening the false sac is that usually adopted in cases where, as in the brachial, we can fully command the circulation on the cardiac side of the tumour ; but in cases such as diffuse or traumatic aneurisms in the cervical or iliac regions, it must be modified. In such cases, the surgeon makes an in-

cision that will barely enable him to insinuate his forefinger, so that it fills up the aperture. He breaks down the coagula within the sac, so that they may be turned out rapidly, and then feels for the opening in the artery, to which he is guided by the flow of warm blood. Keeping his finger firmly pressed upon the wounded point, he rapidly lays open the sac, and turns out its contents, so as to be ready to deal directly and at once with the vessel.

In the case of the brachial, when the clots are evacuated, the wound in the artery can sometimes be readily seen, and then ligatures are applied above and below the opening in the vessel, and the operation completed. (Plate xxv., Figs. 1 and 2.) There is often, however, a difficulty in discovering the wound in the artery, and in such cases, after fairly clearing out the sac, the tourniquet should be slacked a little; this causes a gush of blood to flow from the opening in the artery, which can thus be readily detected. Both ligatures should be placed round the vessel before either is tied, for if the upper ligature be tied first, there may be great difficulty in finding the lower part of the vessel, which becomes flaccid and is not easily recognised : I have seen this occur in practice. Hence it is safer and quite as easy to apply both ligatures properly before tying either.

In false aneurism the coats of the vessel are perfectly healthy, thus differing essentially from the state of the arterial coats in true aneurism, and with the double ligature there is scarcely any danger of secondary hæmorrhage. One ligature alone cannot be trusted to effect a cure on account of the free retrograde circulation ; the vessel must be secured above and below the wounded point.

Under the head of Traumatic or False Aneurisms, I have to direct your attention to two peculiar forms of aneurismal disease —*Aneurismal Varix,* and *Varicose Aneurism;* for although these conditions may arise from disease in some rare cases, they are much more generally caused by a wound implicating an artery and some neighbouring vein.

Dr. William Hunter was the first to draw special attention

to arterio-venous disease, and to point out the two forms in which it occurs. Since then numerous cases of both have been recorded, and observations published in reference to their exact pathological conditions. In both diseases there is communication between the vein and artery; and therefore, as we might expect, there are several symptoms common to both. The similarity of name, and community of general symptoms, have led occasionally to some confusion in regard to treatment; and it is to be regretted that even some writers, who are distinct enough in their description of the two forms of disease, are not equally careful to keep cases of aneurismal varix separate from cases of varicose aneurism when discussing the subject of treatment. It is most essential to remember, in reference to treatment, that however much the two lesions may have in common as regards certain symptoms and appearances, such as the peculiar "bruit," the varicose condition of the neighbouring veins, or the constitutional affection arising from the admixture of venous and arterial blood, their pathological condition differs in one most important point bearing upon practice, and more especially upon the question of operative interference.

Keeping this in view, I shall now describe the symptoms and pathology of aneurismal varix and varicose aneurism, and next consider the rationale of the treatment of each.

In ANEURISMAL VARIX the wound has implicated the artery, and some vein in close contact with it. The bleeding has been arrested by firm pressure at the time, and the parts have healed. The artery and vein adhere directly and closely at the wounded point, so that at each pulsation a jet of arterial blood is projected into the vein, dilating it and destroying the competency of its valves, and gradually leading to a varicose condition of neighbouring veins both deep and superficial. The force with which the arterial stream enters the aperture to the vein, and the meeting of the opposing blood-currents, give rise to a pulsatory movement in the affected veins, attended with a peculiar thrill, and a whizzing sound, which can often be heard even at a little distance. This sound has been compared to various noises—"the

noise of machinery softened by distance," "the sound made by the fly-wheel of a watch much intensified;" perhaps the best is the somewhat ludicrous one—"the noise made by a blue-bottle fly confined in a thin paper bag." The sound, however, is so remarkable that it can hardly be mistaken for any other. In aneurismal varix, the affected vessels, both veins and arteries, undergo changes in structure and function. The arteries have been found dilated and attenuated in their coats, so as to resemble veins in being thin and distensible; and this condition is not limited to the part of the artery wounded, but extends for some distance, and even into the collateral branches. Whilst the neighbouring veins have their valvular structure impaired, and become tortuous and thickened, sometimes that portion of the vein in which the aperture of communication is situated, and which is more immediately exposed to the force of the arterial current, yields, bulges, and forms a remarkable, pulsating, dilatation. There is, however, no formation of an aneurism; for though the natural course of the circulation is disturbed, there is no such obstruction or resistance to the blood-current as takes place in aneurism, and hence there is little risk of such distension as would lead to rupture of the dilated vessel, or of ulceration occurring as in the case of an aneurism. This diseased condition therefore may exist for years, or the greater part of a lifetime, without any marked alteration locally, except perhaps a larger number of veins becoming varicose and pulsating. In some cases, however, it has been observed that patients suffer in general health, owing to the admixture of venous with arterial blood. But in many cases of this form of arterio-venous disease, nothing except the local changes are observed.

VARICOSE ANEURISM consists in the formation of an aneurism, the sac of which has communication with both the artery and vein, and the blood from the artery is projected from the intermediate sac into the vein. Dilatation of the vein implicated, and also of the neighbouring veins, takes place, as in the aneurismal varix, and is accompanied by the same peculiar "bruit," and pulsatory motion in the vein. This form of aneurism is, as I have

already said, generally the result of wound. In the first instance, probably, the compression has not been so effectual as to prevent some blood being extravasated, or to maintain the wounded vessels in perfectly close apposition, and hence blood escapes into the cellular tissue, separating them to a greater extent. The cellular tissue and the textures around become condensed by effused lymph, and thus a false aneurism is formed intermediate between the vein and artery, and common to both these vessels.

The distinguishing features of arterio-venous aneurism are—the varicose state of the veins of the affected part; the pulsatory vibrating sensation felt, or even seen, in these varicose veins; the peculiar whizz or "bruit," more extensively heard towards the trunk than in the distal part of the tumour; the comparative slowness with which the sac enlarges; and the little prominence of the swelling. Most of these peculiarities depend on the abnormal communication with the neighbouring vein. The pulsatory varix, and the peculiar "bruit," are common to varicose aneurism and aneurismal varix, and the causes of their symptoms are similar, and so obvious that I need not repeat what I said when speaking of the latter disease. It differs as to its symptomatology by the presence of a distinct aneurism. I have said that occasionally in aneurismal varix that part of the vein in contact with the artery may bulge, and form a remarkable pulsating swelling, but it is merely a dilatation of the wounded vein, and not at all like the aneurismal tumour in varicose aneurism. In relation to ordinary false aneurism, it differs in respect of its free communication with the vein, on which account the blood-current in the aneurism meets with no resistance in that direction. There is little pressure on the walls of the sac, and hence the comparatively slow enlargement and little prominence of the tumours, for the blood-current does not impinge with much force on the walls of the sac, but finds its way into the circulation through the veins. This last-mentioned condition is most important as to its bearing on the treatment.

The *Treatment* of these two conditions of arterio-venous disease

is founded on a consideration of their pathology. In aneurismal varix we have seen that although there is some alteration in the structure and function of the vessels affected, there is no resistance to the blood-current. There is little more than mere dilatation of the vein connected with the artery, and hence little tendency to such distension as would be likely to lead to rupture or ulceration, and the history of such cases shows us that the disease may exist for years without any great alteration taking place. In aneurismal varix, therefore, operative measures are seldom called for, and all that requires to be done is to give support to the circulation, and prevent further venous dilatation, by bandaging the limb from below upwards, or by the use of elastic or laced stockings.

In varicose aneurism, on the contrary, we cannot leave the disease to take its own course, for though it might be slow in its progress, it would certainly continue to increase, and ultimately either become diffuse throughout the limb, or ulcerate and give way externally. We therefore must have recourse to active treatment. Compression, even at an early stage of the disease, does not answer well, owing to the distended state of the veins, and seems to produce more local irritation and œdema than when applied in other forms of aneurism. The operation of ligature is the best plan of treatment. In the varicose aneurism at the bend of the elbow, the usual plan has been to treat it as a case of ordinary false aneurism, by the direct method of cutting into the sac, and tying the artery above and below the wounded point, and in that region this answers well enough. In other parts of the body, as, for example, the thigh, the plan would be attended with great risk, from the implication of the femoral vein. Mr. Hodgson, in his work on the bloodvessels, recommends ligature of the femoral by the Hunterian plan, trusting that coagulation would take place within the sac, and that the wound of the vein would heal. But the communication through the sac with the vein would offer a free passage for the retrograde circulation; and that, together with the reflux venous current, would form obstacles to coagulation which do not exist in a

circumscribed false aneurism, so that the analogy does not hold. The only two cases I can find, in which the Hunterian method was tried, proved fatal. One occurred in the practice of the late Sir Wm. Lawrence. In it gangrene supervened, amputation was resorted to, and the patient died. The other, a case of varicose aneurism in the popliteal region, resulting from gunshot wound, is recorded by Dr. Dorsey, of Philadelphia. In that case the femoral artery was tied, and fatal secondary hæmorrhage took place. In a case which came under my own care lately, after full consideration of all the circumstances, I operated by placing ligatures on the femoral, both above and below the aneurismal tumour, without opening the sac, so as at once to avoid interference with the vein, and to cut off the disturbing influence of the retrograde current of arterial blood, and so favour consolidation of the contents of the sac. The plan answered my fullest expectations, and I believe it to be the proper procedure in varicose aneurism of the femoral, and even in the brachial, although, as I said, in that region the risk of the ordinary operation is less. The principle of the procedure is to tie the vessel above and below the aneurism, so as to prevent either direct or retrograde blood-current interfering with coagulation and obliteration, whilst we avoid interference with the vein, which we cannot do if we open the aneurism, as the vein communicates with it. (See illustrative Clinical Cases.)

LECTURE LXXII.

Special Aneurisms—Aneurism of the Innominate Artery ; of the Carotid Artery—Special Symptoms attending them : how these are modified by Position—Difficulties in Diagnosis—Treatment—Traumatic or False Aneurism of the Carotid Artery : Mode of Formation ; Treatment—Aneurism of the Subclavian Artery—Advantages and Disadvantages of the Different Modes of Treatment—Axillary Aneurism : Direct and Reflex Symptoms apt to be associated with it—Treatment.

Having concluded the consideration of the pathology of the different forms of aneurism, and the general principles on which our treatment of them is to be conducted, I now proceed to speak of special aneurisms, or aneurisms of particular arteries, commencing with those of the neck and upper extremity.

Aneurisms of the Innominate Artery are not uncommon, but owing to their anatomical relations and peculiarities, they are seldom suited for surgical interference. These conditions render the diagnosis difficult, and the treatment uncertain. We cannot be quite sure that the innominate artery is affected, and the aorta not; and, even should we tie the vessel on the distal side of the aneurism—namely, the right carotid and right subclavian—which is the only treatment possible, there is not very much chance of the disease being cured. Then an aneurism of the innominate artery seldom exists without a portion of the arch of the aorta being involved in the disease. Thus the chances are that the disease will be aggravated rather than relieved by our interference.

Still a cure has been obtained occasionally. Mr. Wardrop once tied the right subclavian and right carotid arteries at different times for aneurism of the innominate, and with a successful result. The only chance we can give the patient is to tie the vessels on the distal side of the aneurism. First, tie the right

carotid, and some little time afterwards the first part of the right subclavian. By doing this the circulation is diverted into the left subclavian and left carotid, and the force of the current of blood passing through the aneurism becomes less and less, until a coagulum forms within the sac; but still there is the disturbing cardiac circulation, which, as it passes through the arch of the aorta, will always tend to wash away the clot in the lower part of the sac, even though it may be perfectly consolidated in its upper part.

Carotid Aneurism, though not very common, is met with occasionally, and generally in patients somewhat advanced in life. It usually occurs at the bifurcation of the common carotid artery, though sometimes lower down, and occasionally also on the internal carotid.

Besides the pulsation in the tumour and the other symptoms common to all aneurisms, there are certain special symptoms to be noticed in carotid aneurisms. If the aneurism be situated near the bifurcation of the common carotid artery, the patient is generally troubled with a constant irritating hacking cough, and spits up mucus, and suffers from much irritation about the larynx. This also occurs when the aneurism is lower down, where it not unfrequently gives rise to spasm of the larynx from pressure on the recurrent laryngeal nerve. If the aneurism be higher up, this symptom is caused by pressure on the superior laryngeal nerve. There is also sometimes difficulty in swallowing from direct pressure of the tumour; the fascia prevents the aneurism passing towards the surface, and it therefore presses in towards the larynx, trachea, and pharynx. In some instances, on looking into the throat, the case looks like one of abscess of the tonsil or pharynx; but in carotid aneurism the projection is generally rounded and circumscribed, and throbbing, while in pharyngeal abscess the swelling is more diffuse. When a carotid aneurism presses inwards, it may give rise to very serious dyspnœa if the tumour be of large size; and even after tying the artery, we sometimes find that tracheotomy is required owing to the general swelling, hardening, and

coagulation within the sac of the aneurism and the effusion of lymph around the nerves in the neighbourhood aggravating the symptoms. The special symptoms of carotid aneurism are the constant cough, irritation about the larynx, and difficulty of deglutition, arising from pressure on the vagus and its branches, the latter symptom being most marked when the nerves of the pharyngeal plexus are pressed upon. In a case of abscess in one of the glands of the neck these symptoms will not be so marked ; and in the superficial glands the swelling would press towards the skin rather than deeply.

According to the situation of the aneurism the symptoms accompanying it will vary. In carotid aneurism, occurring, as it usually does, at the bifurcation of the common carotid trunk, certain points are to be attended to as regards diagnosis. From below the anterior belly of the omo-hyoid muscle, the carotid artery lies merely covered by the skin and fascia; but under the deep fascia in this region is a chain of glands passing from the subclavian space upwards, which come to lie superficial to the artery. Those at the lower part of the neck lie generally behind the vessel, but others pass up from the subclavian space below the sterno-mastoid muscle, and lie in front of the artery, sometimes below the fascia, but still in front of the vessel. One of these glands may enlarge, inflame, and suppurate ; the suppuration may be of a chronic form, there may be no discoloration of the skin, and the symptoms may be those of carotid aneurism. The pulsation may be pretty strong, and the patient may complain of pain and the other symptoms of aneurism; but if they arise from a gland which has become enlarged, there are certain circumstances in the history of the case, and also in the state of the parts at the time, which ought to guide us in forming a correct diagnosis. If the swelling be fluid, or nearly so, and if it pulsates pretty freely, then it can only be either a carotid aneurism in the earlier stage of its formation, or a suppurating gland, and if the patient say that the swelling was first hard and then became soft, we can have no doubt that it is a gland which has inflamed and suppurated, for an aneurism would be soft and fluid in the first

instance and become harder afterwards. Moreover, the pulsation will not be expansile, though it may be very distinct, and the fluid will not be repressible, for we cannot press the purulent matter back out of the swelling as we could if it were an aneurism, which can be compressed, and which, on removing the pressure, would fill again with a bound. Then, by pressing on the carotid artery lower down, an aneurism would become flaccid, while an enlarged gland would remain unaffected. We are often told that the best way of arriving at a correct diagnosis is to make the patient relax the head while we at the same time draw away the swelling from over the artery. If it be an enlarged gland, we do not then feel any pulsation in it. We cannot, however, always effect this, for the sheath of the artery and the gland may be connected together as the result of chronic inflammation. The three other symptoms before mentioned should, however, enable us to form a correct diagnosis in all cases.

An aneurism may form on the carotid artery lower down than where it bifurcates, and then there may be greater difficulty in the diagnosis. I have seen a tumour with a very distinct pulsation situated there, which could be made to disappear by gradual compression. In that case the artery was tied, and the swelling seemed to disappear, but after the patient's death it was found that there had been no aneurism at all, that in fact the swelling was a chronic abscess amongst the deep-seated glands along the common carotid trunk, which had passed into the anterior mediastinum, so that the apparent repression of the fluid was caused by its passage into the mediastinum. With ordinary care and attention to the history of the case these mistakes will generally be avoided. The really difficult cases to diagnose are those of vascular erectile tumours situated upon the course of the artery indirectly communicating with it or the jugular vein. In such cases the symptoms are almost identical with those of aneurism.

As regards the *Treatment* of carotid aneurism, as in that of the iliac arteries, compression is out of the question, and therefore the only plan is to tie the artery. But it is only in certain

cases that we can do so with prospect of success—namely, in those where the vessels are tolerably healthy. In carotid aneurism the arteries are generally very extensively diseased; the common carotid throughout its whole extent is sometimes atheromatous, with earthy deposits in its coats; and such a case would not be well suited for the application of a ligature. There is no fear of interrupting the circulation in the brain after ligature of the carotid, though this was formerly considered to be a great danger. Both carotids may be tied, and yet the circulation will be carried on perfectly. The very opposite danger is in fact greater, for the retrograde circulation may be too free. When the common carotid is tied, the circulation is carried on almost immediately into the parts above. The branches of the thyroid, lingual, and facial arteries, form a series of anastomoses with each other so free, that it is a wonder the circulation is not at once re-established. Besides these branches, there is also the internal carotid artery, which is filled almost immediately through the circle of Willis. The danger really arises in consequence of the blood from the collateral branches collecting on the distal side of the aneurism, acting as a disturbing cause, and preventing the hæmostatic changes taking place. The proximal side of the carotid artery is a long trunk, without any collateral branches coming off from it. The disturbing causes on the proximal side are great, on account of this part of the vessel being so near the heart, thus differing from the external iliac artery. There is then a very powerful retrograde distal force, as well as the great cardiac force, to prevent the hæmostatic changes taking place; and, besides, the vessel is very often in an unhealthy condition, so that in carotid aneurism we require to be very careful in selecting proper cases on which to operate.

Even in aneurism quite adjoining the innominate artery, the carotid has been tied, and with success, though it was a very unfavourable case for such a procedure. Ligature of the common carotid artery, though a comparatively easy operation, is sometimes not so very simple as you might expect, and, when the parts are much matted together, it may become very difficult.

Traumatic or False Aneurism of the Carotid Artery.—A wound of the carotid artery generally causes almost immediate death from the hæmorrhage which results; but if the artery be merely punctured, and if it be compressed at the time, the external flow of blood is stopped, but it is extravasated, and forms a false aneurism. There is formed a distinctly pulsating tumour, the pulsation at those points where the clot is formed in the cellular tissue not being so marked as it is directly over the vessel. It is sometimes so far circumscribed, but generally it diffuses itself backwards under the sterno-mastoid. In such cases an incision should be made through the skin, along the line of the lower part of the sterno-mastoid, so as to lay bare the artery, and permit compression to be made on the vessel between the heart and the wounded point, without interfering with the aneurism. A small incision, just sufficient to admit the finger, is made over the aneurism, and the clot broken up by the finger, so that it can be easily removed. The artery is then compressed at the wounded part by the point of the finger, and the clot of blood turned out. Ligatures are then passed, one above and the other below the wound in the vessel, and tied. This is not always easy, on account of the matting and discoloration of the parts, and great care is required in tying the vessel. There may be some difficulty in finding the wounded point, and hence the necessity for making an incision in the lower part of the neck, so as to give us the power of compression on the proximal side of the wound. If, without taking these precautions, we cut down on the aneurism at once, as we should do in a false aneurism at the bend of the arm, an immense and probably fatal gush of blood would take place immediately, since there would be no control over the artery.

Aneurisms of the Subclavian Artery may occur at almost any part of the vessel—very generally at the middle part; in which case there is a pulsating tumour projecting the sterno-mastoid forwards. Some aneurisms of the aorta may simulate subclavian aneurism, and cause a difficulty in the diagnosis. In Allan Burn's *Anatomy of the Head and*

Neck much valuable information will be found on aneurisms in this region. He mentions a case of aneurism of the aorta closely resembling an aneurism of the subclavian. They may also simulate aneurisms in the third part of the subclavian, but this is not common. In aneurisms of the middle or third part of the subclavian artery, the question of treatment is very difficult. When the first part of the artery is tolerably healthy, there are three plans of treatment which may be adopted—namely, to tie the innominate artery, the first part of the subclavian, or the first part of the axillary—(*i.e.* on the distal side of the aneurism, according to Brasdor's operation). In all these operations there is a great deal of danger. In aneurism of the middle portion of the subclavian there is a great probability of the diseased condition extending beyond the tumour, and besides, the first part of the artery is not well suited for ligature, from its shortness, and from the important parts in the neighbourhood. In front of it is the vagus nerve with its recurrent branches ; behind and below it is the right pleura; external to it is the internal jugular vein; and close to it is the vertebral vein. All these important structures lying within a very small space. This makes the operation a difficult one ; but that of itself is not a sufficient reason for not performing it. Another and great objection to the operation is that there is a very short space of the vessel in which the hæmostatic process can take place. On the cardiac side of it are the innominate and right carotid arteries, while on the distal side are the vertebral and internal mammary arteries and the thyroid axis, all acting as disturbing causes to the natural hæmostatic changes.

Another plan of treatment is ligature of the innominate artery ; this is not a difficult operation. The artery, though deeply situated, can be readily enough exposed, and the operation was formerly preferred on this account. It was thought that the only difficulty would be the sudden interference with the supply of blood to the right side of the head and neck ; but in practice it was found that the very opposite result took place, and that the retrograde circulation on the distal side of the ligature formed the

chief disturbing cause. The operation, however, has been almost uniformly unsuccessful. The last time it was performed in this country was by the late Professor Lizars, in a case of true aneurism formed after a slight injury (not a wound) of the subclavian, arising from a fracture of the clavicle. I never saw an operation performed in a more masterly style. The vessel was very little disturbed, and the circumstances of the case were most favourable, the vessels generally being healthy. The patient went on well for some time, but on the 13th day fatal hæmorrhage came on. Hence the operation, though not a difficult one, has been generally given up on account of the unfortunate results.

The third method of treatment is Brasdor's operation of tying the axillary artery on the distal side of the aneurism ; but it has proved little, if at all, more successful than either of the other methods. In most cases gangrene of the arm came on before the collateral circulation was fully established, while, at other times, secondary hæmorrhage resulted.

Another method has been suggested :—that of cutting directly into the sac of the aneurism, and tying the vessel on either side—first clearing the innominate artery so as to allow of direct compression on it. But though we may command the innominate artery, we cannot control the vertebral arteries, which would pour their blood into the sac ; and even supposing the vertebral circulation could be commanded, we should be compelled to tie the subclavian at the worst part of its course—namely, in the middle portion, just where the thyroid axis comes off. This operation should, therefore, never be performed. The question is thus narrowed to the plan of tying the innominate artery, or of having recourse to the mode of treatment recommended by Sir William Fergusson—namely, amputating the arm at the shoulder-joint in cases of aneurism of the middle or third portion of the subclavian artery, and tying the axillary artery as high up as possible : we should thus be performing Brasdor's operation, while we should also remove the source of attraction of the blood from the distal side of the aneu-

rism. The blood would no longer be required for the arm, and the function of the affected artery would be done away with. In one case, lately, I performed this operation in a case of fusiform aneurism of the subclavian artery with benefit, but without effecting a complete cure: still I believe that, under more favourable circumstances, a successful result would be obtained. The patient on whom I operated is still alive.* When he left the hospital the aneurism was all but consolidated, but three or four years afterwards the swelling began to return, this being due, I believe, to a fresh dilatation of the vessel rather than to any change in the consolidated sac of the aneurism. I feel quite sure, however, that if the innominate artery had been tied in this case, the patient would have died long ago. I would, therefore, try this operation again in preference to tying the innominate artery, and in doing it I should tie the axillary as high up as possible—namely, just at the clavicle—before removing the arm, partly to avoid the bleeding from the large number of muscular branches given off by the artery, and partly also because we should be able to tie the vessel as near as possible to the distal side of the aneurism.† We should always remember, in reference to this subject, that the innominate artery may not be present, the carotid and subclavian arteries in those cases arising directly from the aorta. In one of Mr. Liston's cases such was the arrangement, such also occurs in the preparation which I now show you.

Aneurisms of the Axillary Artery are much more frequent and much more amenable to treatment than those of the subclavian. They arise from various causes, as from great muscular exertion of the arm. They may be either fusiform or saccular, as when there is ulceration of the middle and internal coats, with dilatation of the external coat of the artery. When it is a true lateral saccular aneurism, it forms a rounded projection on one side of the artery, and as it enlarges we find peculiar symptoms connected with it, but such as are apt to mislead unless we are on our guard. A great many cases of this aneurism have been overlooked, under the belief that they were cases of rheumatism of the arm and shoulder. The

* Died in 1868. See Clinical Cases. † See Clinical Cases.

patient complains of rheumatic pains in the hand and arm, and, without examination, rubbing and other remedies are recommended, but the pain becomes very severe, an examination is then made, the pulsating tumour in the axillary is at once felt, and the cause of the pain is recognised. The pulsation is very free and regular, and all the ordinary symptoms of aneurism are well marked. In cases of axillary aneurism we are told that one of the great difficulties in the operation depends on the size of the aneurism—the shoulder being elevated when it is very large, and the third part of the subclavian being consequently very deeply situated—and doubtless this is the case, but the real cause of the elevation of the shoulder is not necessarily the large size of the aneurism. Sometimes, when the tumour is very large, there is not much elevation of the shoulder; and, again, the shoulder may be very much raised long before the aneurism has attained any great size. The real cause of the elevation of the shoulder is the pressure of the tumour on the axillary plexus of nerves. The patient instinctively raises his shoulder to try to remove this pressure as much as possible. In very large axillary aneurisms, the tumour presses forwards and inwards, away from the nerves, and the pectoral muscles yield before the tumour, so that the shoulder is not raised in proportion to the size of the aneurism.

The œdema of the limb depends on the bulk or solidity of the tumour. When it gets very solid it presses on the veins, and always causes more or less œdema of the arm, often with a varicose state of the veins, and an increase of pain. In the fusiform axillary aneurism there is always great pain, owing to the equal dilatation of the affected portion of the vessel, causing it to press on all the nerves which closely surround it (Plate xxiv. Fig. 4). In some cases of axillary aneurism, we find the tumour suddenly enlarge, as if a partial effusion of its contents had taken place, and very likely in many cases, though not always, this is the cause of it. In popliteal aneurism, when there is rupture of part of the sac, with effusion of blood from it, we have the whole limb engorged; but in the axillary aneurism it is not so, for there the fascial textures on all sides of the tumour form

a sort of limiting cyst or sac, preventing the effusion of blood amongst the muscles of the limb.

The *Treatment* of axillary aneurism is to tie the vessel by the Hunterian method on the proximal side of the aneurism, and the third or outer portion of the subclavian is the point of election. There is no use in tying the first portion of the axillary artery, for we are then merely getting at the third part of the subclavian by a roundabout method, unless we tie it close to the origin of the acromial thoracic artery. By tying the subclavian artery in the subclavian space, we leave plenty of room for obliteration of the vessel taking place on both sides of the ligature, and there are no great branches so near as to form disturbing influences to the process of cure. Hence, although ligature of the third portion of the subclavian is a somewhat difficult operation, and though there is a risk of secondary hæmorrhage, still it is, as a general rule, the proper treatment to adopt in cases of true axillary aneurism.

Where the aneurism hàs enlarged very rapidly, and we think it has become diffuse, and where the limiting sac to which we trusted in the former case has given way, we may adopt another method of treatment. The pressure of such bulky diffuse aneurisms, together with the effects of the ligature, might lead to gangrene of the arm (to say nothing of the risk of secondary hæmorrhage), and, from partial rupture of the sac, consolidation is not so likely to be completed. Under such circumstances we may adopt the following plan :—Cut down on the third part of the subclavian, so as to admit of complete compression of it by an assistant, while the brachial artery below is also compressed. Then cut into the aneurism in the axilla, turn out the clot from its interior, and tie the vessel above and below the ruptured point. If the precautions of compressing the subclavian and brachial arteries be attended to and properly effected, no bleeding can take place. When the surgeon sees the opening from which the blood has escaped, the vessel is tied above and below that point. But the aperture cannot always be seen, and then the compression must be cautiously relaxed,

and the jet of blood directs attention to the part. It is said by some that the chances are as great of finding a healthy part of the artery near the aneurism as at a distance from it ; but this is not quite correct. This is an exceptional method of treating these aneurisms, and it is of great value in proper cases ; but when proposed as a method to take the place of the Hunterian plan in all cases, the proposition goes against all our knowledge of surgical pathology and our past experience. It is just the old operation for aneurism revived.

LECTURE LXXIII.

Aneurisms of the Brachial Artery; True and False; Treatment—True and False Aneurisms of the Radial and Ulnar Arteries; Treatment; Case—Inguinal Aneurisms—Aneurisms of the Gluteal, of the Common Iliac, of the Femoral, of the Popliteal Arteries—Symptoms: Diagnosis and Treatment proper to each.

True Aneurism of the Brachial Artery is seldom or never met with. The treatment of such a case, should it occur, would consist either in tying the brachial some little distance above the aneurism, or in applying compression by means of a ring-tourniquet, to exercise direct compression on the artery above the aneurism, whilst the collateral circulation would be left free.

False Aneurism of the Brachial used to be very frequent, when venesection was considered a universal panacea, not only for the cure but also for the prevention of disease, and when the healthy as well as the sick had themselves bled at certain periods of the year. In those days the operation was performed by gardeners, farriers, and others, with the result of supplying the surgeon with numerous cases of false aneurism at the bend of the arm, arising from puncture of the brachial artery. In the present day false aneurism at the bend of the arm is almost as rare as true aneurism in that locality. In fact, we rarely meet with it now, and almost never as the result of venesection.

When present, the diagnosis is easy enough, but the appearance of the aneurism will differ according to circumstances. If the wound of the artery has been large, and the blood widely diffused, we have a flat irregular pulsating tumour, hard towards the circumference, and softer and with more pulsation near its centre. In one case which I saw, where the wound of the artery resulted from a stab, or rather a cut with a sharp triangular-

bladed knife, and where compression had been used at first, the blood passed upwards under the fascia and skin of the upper arm as well as towards the forearm, and gave rise to enormous distension, having formed a huge sac of blood, partly fluid, partly coagulated. In other cases, when the original wound has been small, and compression has been applied so as to arrest the escape of blood to some extent, a small circumscribed false aneurism forms, and from effusion of lymph condensing the surrounding tissues the blood is limited by an adventitious sac, and this limitation causes the aneurism in some respects to resemble a true aneurism as regards the chances of coagulation of the contained blood. In cases of aneurism in the arm or at the bend of the elbow, when the disease has existed for any time, there is generally numbness of the thumb and of the fingers supplied by the median nerve, owing to that structure being stretched or pressed on by the swelling; and from the same cause and the tension of the aponeurosis of the forearm and semilunar fascia, the elbow is slightly bent and the fingers contracted.

In regard to *Treatment*, the safest method is to lay open the sac, turn out its contents, and then tie the artery immediately above and below the wounded point, as described in Lecture LXXI. at page 559, and figured in Plate xxv. In cases of old-standing circumscribed false aneurism, the Hunterian method may be adopted, as in true aneurism, and has proved successful in certain cases of false aneurism of the femoral. I have stated my opinion that this plan has advantages, on account of the anatomical complications in that region. But in the case of the brachial, I believe the direct method of opening the sac and tying the vessel above and below the wounded point to be the surest of success.

In cases of False Aneurism of the Radial or Ulnar Arteries, the direct method is the only one we can employ, owing to the very free anastomoses between the vessels of the forearm. Even in those peculiar true aneurisms of the radial, occasionally met with on the back of the wrist near the thumb, I think that, to ensure a cure, a ligature above and below the

aneurism should be used: the free inosculations through the palmar arches would otherwise be likely to prevent coagulation and consolidation of the contents of the sac. In cases of false aneurism of the radial or ulnar following injuries, we require to be on our guard against a wrong diagnosis. During this last summer, a man was sent to my care by Dr. Cochrane of Auchterarder, with a false aneurism of the radial, which had followed upon a comminuted fracture of the radius. After the fracture united, the aneurism showed itself. When admitted into hospital, the appearance was exceedingly like that of an abscess about to burst. The skin over the swelling was red and tense, and very thin and pointing in the centre. A hurried look at the swelling might have easily led an incautious person to plunge a lancet into the aneurism. The skin was so thin and tense that I operated immediately on his admission. The opening in the artery was very large and easily recognised, without relaxing the tourniquet. The case did well.

I now proceed to speak of aneurisms occurring in the pelvis and lower extremity, commencing with

Inguinal Aneurisms.—These are aneurisms affecting the external iliac artery. They are not very common. We must be careful to distinguish them from soft malignant tumours arising in the iliac fossa, and possessing a slightly pulsating feeling. In many cases these tumours are very vascular, with a large vessel breaking up in their interior and communicating to the tumour a feeling of pulsation very like that of an aneurism. Such tumours have been more than once mistaken for inguinal aneurisms. Another form of disease situated in this region, though of very rare occurrence, is the disease of bone called osteo-aneurism. This consists in a peculiar arrangement of the vessels in the bones of the pelvis. It is, in fact, an erectile tumour of bone. It somewhat resembles an aneurism, but is never well circumscribed. It has an irregular form, and wants the sac which an aneurism possesses. If the disease has existed for some time, it may be rather difficult to distin-

guish it from inguinal aneurism, though it never resembles that disease so closely as the soft malignant tumour does.

The special symptoms of an aneurism in the groin, or inguinal aneurism, are generally pain in the lumbar region, along the crest of the ilium, in the neighbourhood of the testicle and scrotum, and also down the front and outer side of the thigh. This is referable to the stretching of the branches of the ilio-lumbar nerve, passing in front of the vessel. The anterior crural nerve is not directly pressed upon unless the aneurism be very large. The painful symptoms, therefore, are chiefly referable to pressure on the ilio-lumbar nerves, and impeded circulation in the limb.

The other aneurisms occurring here are connected with the vessels arising from the internal iliac, and may be either true or traumatic aneurisms. The ischiatic artery is very rarely affected with aneurism, the vessel most commonly affected in that region being the gluteal artery, which may be wounded by a person sitting down on any sharp instrument. An aneurism may also form spontaneously on the gluteal artery; and in that case I hold that the proper plan of treatment is to tie either the internal iliac or the common iliac artery. This is certainly better than cutting into the sac and dealing with the aneurism there, which is unsatisfactory in its results, for in cases where a cure has been supposed to be effected by this operation, the disease has afterwards returned; and hence I think it is better to tie the internal or common iliac artery by the Hunterian method, preferring the internal iliac in all cases where that is possible. Another reason for adopting this plan of treatment is, that we cannot be sure that we are dealing with a case of aneurism of the gluteal artery, as the diseased vessel may be some other branch of the internal iliac.

In cases of Traumatic Aneurism of the Gluteal Artery, arising from a wound in the hip, the tumour will be diffuse, and must be treated like any other false aneurism. The abdominal aorta must be compressed, and a free incision, nearly a foot in length, made into the tumour, the contents of the sac

turned out, and a double ligature applied to the vessel. In doing this, we must remember that when the gluteal trunk is wounded it generally retracts partly within the pelvis, leaving a long tubular prolongation, which, if tied, will almost certainly give way. Therefore the vessel must be secured higher up, where it is not abnormally dilated, as it is a very long artery, without any collateral branches till where it gives off the epigastric and circumflex ilii. The operation to be performed will depend on the position and extent of the aneurism. If it be not extensive, or situated high up, we may place a ligature above the affected part; but if there be not room for this, then the common iliac must be tied. In all these aneurisms compression and flexion are out of the question, and there is therefore no other treatment which can be adopted than ligature of the common iliac. Aneurisms of the external iliac may attain a very large size, even though the artery be not very much affected. By its length the aneurism may displace the upper healthy part of the vessel, raising it on its surface, or pushing it aside or upwards.

In these aneurisms we sometimes require to cut down on the sac, turn out its contents, and tie the vessel above and below. This is a very complicated operation, though it may be beneficial sometimes when the aneurism is to a certain extent diffuse; but still it is very uncertain. The coats of the vessels are very likely to be diseased; and, besides, the operation is attended with some uncertainty as to what is tied. In one case the external iliac, the internal iliac, and the common iliac, were supposed to be tied, but after death it was found that the external iliac was the only one of the three vessels which had really been ligatured. It is best to make a free incision through the abdominal parietes, and examine the artery carefully, both above and below the aneurism, before opening the sac and applying the ligature; but this operation is only applicable to exceptional cases of true aneurism.

Aneurisms of the Common Iliac Artery, or of the abdominal aorta, are not of unfrequent occurrence. These, however, are

rather medical than surgical cases. The abdominal aorta has been tied several times for aneurismal disease or hæmorrhage, but never with success. The operation is not likely to prove successful, and is not to be recommended.

The term Femoral Aneurism is applied to an aneurism arising on any part of the femoral artery, from the point where it passes through the opening in the adductor magnus up to where it becomes the external iliac artery. The term is, therefore, a very wide one, and the methods of cure are very different in different cases. When the aneurism, as generally happens, is high up, in or near Scarpa's triangle, it is too close to the origin of the superficial femoral to allow us to tie that vessel, and in such cases the external iliac artery should be ligatured. But many femoral aneurisms occur below this point, and then it is not necessary to tie the external iliac, as there is plenty of space between the aneurism and a healthy portion of the femoral artery to allow us to tie the latter vessel. In these cases there is a better chance of a cure being effected (because there are fewer collateral branches, which might cause a reappearance of the aneurism), than if the external iliac were tied when the aneurism is low down in the thigh, for then there would be a large number of branches of communication between the aneurism and the ligature.

In femoral the pain is not so severe as in popliteal aneurism. It is chiefly complained of on the inner side of the knee, owing to pressure on the obturator and saphenus nerves. The common femoral is a very short vessel, and gives off many collateral branches, such as the superficial epigastric, the circumflex ilii, and inguino-pudic, and then it divides into the superficial and deep femoral arteries. On this account I would never tie the common femoral artery, except for direct wound.

When a femoral aneurism is situated above Hunter's canal, and towards the groin, the external iliac is the proper vessel to tie; but when the aneurism is lower down, the superficial femoral should be tied. It is not safe to put off much time by trying compression in cases of femoral aneurism; the sooner the ligature is applied the better.

Traumatic Aneurism of the Femoral Artery may occur from a wound of that vessel. Here, as in all other false aneurisms, the treatment consists in enlarging the wound, and tying the vessel above and below the injured point. If the femoral vein be wounded, as well as the artery, amputation may be required, though we should always give the patient the chance of retaining the limb by first tying the artery above and below. When in applying a ligature to the artery we happen to wound the vein, it is generally transfixed, so that a part of the coats of the vein is tied along with the artery, and then pyæmia and gangrene will probably result, unless we withdraw the ligature at once, and reapply it more carefully to the artery alone. In an accidental wound the circumstances are different, for if the artery be tied the venous bleeding will soon cease, and bad symptoms may not follow, though the risks of gangrene are very great.

A traumatic aneurism occurs in this way:—The patient receives a stab, which wounds the artery, say in Hunter's canal, and the bleeding is arrested at the time. A false aneurism follows, which is somewhat diffused, though still circumscribed by the anatomical disposition of the parts. What treatment should be adopted in such a case? As a general principle, in all false aneurisms we should cut down on the tumour, and put a double ligature round the artery; but in the case of a wound of the femoral artery in Hunter's canal, there are some peculiar conditions to be attended to. If the aneurism be not very diffuse, I should feel very much inclined to use the Hunterian method of treatment, and tie the femoral at the lower part of Scarpa's triangle. The vein may have escaped injury by the wound, but the parts are all matted together, and the risks of interfering with them are very considerable, lest the vein be wounded in the operation. The Hunterian plan of treatment has proved successful in several cases; and though the ordinary method is quite satisfactory, the Hunterian plan may, as an exception to the ordinary rule, be employed advantageously in such a case as this. In one of the Continental hospitals I have seen the common femoral ligatured for a traumatic aneurism in

the lower part of the thigh, but in this case secondary hæmorrhage came on. The external iliac was then tied; the same result again took place, and the patient died. But why tie the common femoral for traumatic aneurism of the superficial femoral, when there are so many collateral branches coming off from it? It would be better to clear out the contents of the sac of the aneurism, and tie the vessel above and below the opening. Where a false aneurism has existed for some time, and where it is so far circumscribed, if it be pretty solid, we may then adopt either the usual plan of treatment, or, what I consider better, we may tie the femoral artery in Scarpa's triangle, as in cases of true aneurism. The treatment of traumatic varicose aneurism and aneurismal varix has been already fully discussed, and I would refer you to the instance given amongst the Clinical Cases for the method which I would recommend of treating varicose aneurism of the femoral.

Popliteal Aneurism is that which probably more than any other becomes the subject of surgical treatment.

This aneurism is generally situated towards the middle or lower part of the popliteal space, though it may exist at any part of it. The symptoms are as follow:—The patient is generally aware of something giving way during some exertion; then slight lameness follows, accompanied with a dull aching feeling in the limb, but this passes off. After a time a small pulsating tumour forms. Sometimes the patient is not conscious of the first symptom, nor even of the presence of the swelling until the surgeon recognises it. He often complains of rheumatic pains in the limb, of coldness of the foot, and numbing pains in the back of the leg. These extend sometimes along the course of the sciatic nerve, arising either from direct pressure on the nervous trunks, or from enlargement of the neurilemmal vessels. On examining the state of the parts, we see how the pressure on the nerves would give rise to these symptoms—direct pressure backwards upon the popliteal or posterior tibial nerve causes the tension and irritation, and this takes place to some extent even when the tumour is still fluid. On placing the

hand on the tumour, we feel the expansile pulsation in it. In the early stage the blood in the sac is quite fluid, and then by compressing it we can repress the contents into the circulation, and so make the swelling disappear. On removing the pressure, it fills again with a bound, as is the case in all true aneurisms. The same thing also takes place when we compress the femoral artery, so long as the tumour is still fluid.

The aneurism may begin in another way, if it be fusiform. This form, however, is very rare in the popliteal space. In my own practice I have only met with one example of fusiform popliteal aneurism. In such cases the patient feels pain and uneasiness in the site of the aneurism, and some coldness of the limb, with numbness and a pricking sensation from the irregular circulation, but not from pressure on the nerves, for in the early stage this kind of aneurism is just like a dilated artery. We feel the artery pulsating more distinctly than we can do in the healthy limb. There is in fact simply a dilatation at one point of the vessel, which gradually narrows on either side of the dilatation, giving the aneurism a peculiar spindle-like shape.

The ordinary true aneurism may attain a very large size. In it the internal and middle coats of the artery give way, and the external fibro-cellular coat forms the sac of the aneurism. The pain and tension increase as the tumour becomes solid, while the pulsation diminishes. Some œdema of the limb also takes place, and there may be a difficulty in the diagnosis of the case. Sometimes the aneurism proceeds very rapidly; it may burst and become diffuse, and then there is a total alteration in the symptoms : the blood is effused into the limb, the collateral as well as the main circulation is impeded, and gangrene generally results in such cases. The early symptoms of popliteal aneurism are not unlike those of rheumatism, or the accidental rupture of the fibres of the gastrocnemius from unwonted exercise, where we find numbness, stiffness, and some of the other symptoms of popliteal aneurism. On the other hand it is quite possible that a small amount of exertion may rupture the coats of the artery and lead to the formation of an

aneurism ; and therefore, when these symptoms are present, we ought carefully to examine the limb, so as to see whether or not an aneurism exist, and we must not be careless in trusting to the history, or too sure that the injury is only rupture of some muscular fibres. As regards malignant growths in this neighbourhood, the appearance of the tumour and the history of the case should enable us to form a correct diagnosis. In a case of erectile tumour, or aneurism by anastomosis as it is called, the symptoms may be so identical with those of true aneurism as almost to prevent us from being quite certain as to the true nature of the case till we cut down upon the growth ; but this form of disease is very rare in the popliteal space, while in the position of the posterior tibial or peroneal arteries, where it is more common, the true aneurism is very seldom met with.

As regards the *Treatment* of popliteal aneurism : If we see the patient in the early stage of the disease, while the tumour is not very large, and whilst the contents of the sac are perfectly fluid, unless the disease threatens to go on very rapidly, it is well to give the patient some rest before operating. We should employ means to hasten the formation of the coagulum within the sac, and so favour the application of the ligature afterwards. The reason why I advise this practice is, that in the fluid state of the aneurism there is no obstruction to the collateral circulation into the sac, and if we tie the artery in this stage, the blood would likely get into the aneurism again by these collateral branches, and by its disturbing force prevent coagulation of the contents of the sac. While there is no coagulum within the sac, the collateral branches easily re-establish the circulation in it, and between it and the ligature. A period of rest, therefore, should be enjoined in this early stage, before operating, whilst we employ flexion of the limb, and also compression over the artery where it lies in Hunter's canal, so as to prevent any risk of rupture of the aneurismal sac during the flexion. The method of carrying out the treatment by flexion in cases of popliteal aneurism is as follows :—A close-fitting stocking or slipper is placed on the foot, and to it is fixed a piece of tape or strap ; round the

upper part of the thigh or pelvis there is a band of cotton or a leather circle with another tape attached to it. The two pieces of tape are then brought together and tied, or the straps buckled, and in this way we can gradually flex the limb so as to bring the heel up towards the thigh (as in the treatment of ruptured tendo Achillis, Plate xx. Fig. 3). The patient should rest on the side, on a large water-pillow, and the thigh should be flexed upon the pelvis, as well as the leg upon the thigh, so as still further to obstruct the circulation. When the flexion is complete the circulation is thoroughly obstructed, but it is very seldom that the patient can bear complete flexion. Even when not complete, however, the flexion impedes the force of the blood-current, and gives time for a certain amount of coagulum to form within the sac. This treatment alone may bring about a cure, and even if it does not, it brings the aneurism into a better state for the application of the ligature. In using flexion in the early or fluid stage of popliteal aneurism, prior and preparatory to ligature, compression should be employed at the same time to prevent any risk of rupture taking place, and to facilitate still further the natural cure. The compression should, I think, be applied on the vessel as it passes through Hunter's canal, though that is not the place generally recommended. If we apply compression alone, according to the method of cure by compression, we must have a special apparatus for the purpose. We are generally recommended to apply compression at various points, changing them from time to time so as to prevent any ulceration of the soft parts over the artery. All that is required, it is said, is to slow the current of blood through the artery,—not to stop it completely—and to direct the blood upon the collateral circulation, so as to favour the coagulation of the contents of the aneurismal sac.

For my own part, I believe that our success will depend on how far we are able to arrest the circulation through the femoral completely. If we can effect complete arrestment by digital compression, or instruments so modified as to enable the patient to bear pressure sufficient for the purpose, the chances of cure will be much better. I must say, however, that from what I

Plate XXVI

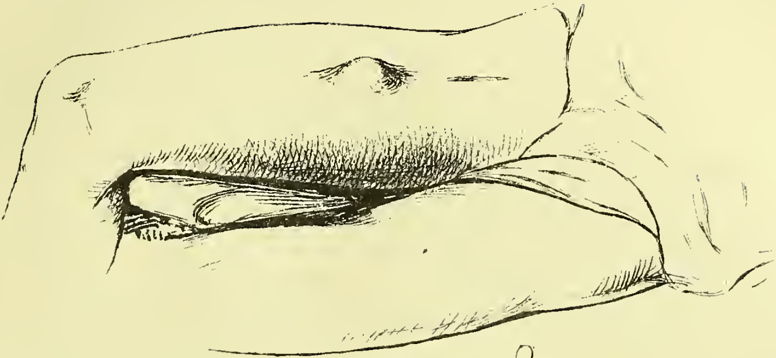

Fig. 1

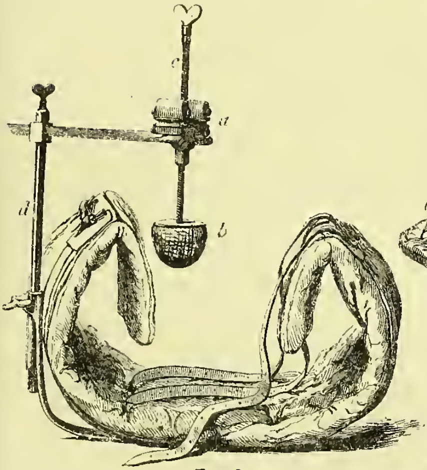

Fig. 2

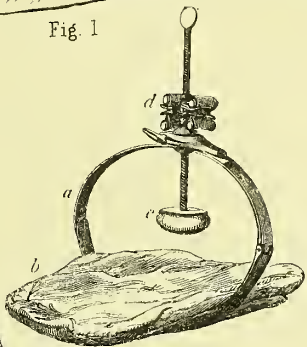

Fig. 3

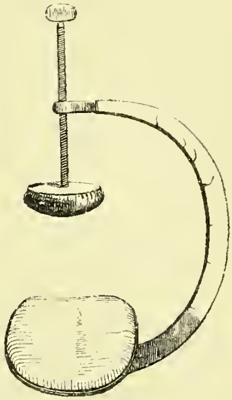

Fig. 4

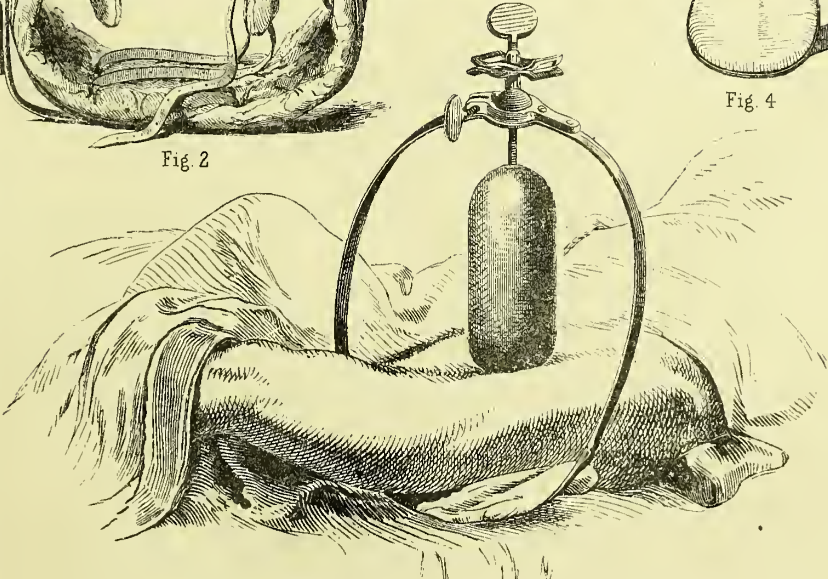

Fig. 5

have seen of it, I do not like the treatment by compression for popliteal aneurism, as it is uncertain in its results, and is attended with danger from sloughing and from gangrene, which may supervene. I consider that ligature of the femoral is far preferable to it. The only case in which I should adopt the treatment by compression at all would be in the fusiform aneurism, or in the early stage of saccular aneurism, when the contents of the sac are fluid. Flexion, along with slight compression, may be of use in the beginning of the disease, when the aneurism is still fluid, but if there be any amount of coagulum within the sac I should prefer ligature of the artery as soon as the patient was in a fit state for the operation.

True aneurisms of the arteries of the leg are exceedingly rare, but erectile tumours situated on the course of these arteries very closely simulate the symptoms of true aneurism. In cases of false aneurism in this region the general diagnosis is easy enough, but it is often difficult to know certainly which artery is wounded, or whether more than one vessel is implicated. Thus a deep stab from the fore part of the leg may wound not only the anterior tibial, but perforate the interosseous membrane and wound the posterior also. Or a wound inflicted from the posterior aspect of the leg may reach the anterior tibial, or, if high up, may divide the peroneal as well as the posterior tibial. On the other hand, none of the main vessels may be wounded, but the aneurismal swelling may arise from a wound of the large sural arteries. For these reasons, as regards the treatment, I have no hesitation in advising you always to adopt the direct method. Apply a tourniquet to command the circulation, and dilate the wound freely, so as to see distinctly the injured vessel or vessels, and tie above and below the wounded point.

CLINICAL CASES

ILLUSTRATING THE TREATMENT OF INJURIES OF ARTERIES.

WOUNDS OF ARTERIES.—From *Clinical Report*, 1865-6.

1. C. C., æt. 5, admitted 4th December. Was kicked by a horse on the inner side of the left thigh in the lower third. Wound bled so profusely that she fainted, after which the bleeding ceased. When conveyed to hospital, Mr. Spence, on examination, found the wound to be small and transverse in direction. On introducing his finger he discovered that the femoral artery had been completely torn across, and that its lower portion was retracted into the popliteal space, while at the same time the upper portion was felt beating in the upper part of the wound. The vein was also divided, the contiguous muscles were lacerated and bruised, and the bone laid bare. Leg cold; no pulsation in tibials. Mr. Spence immediately enlarged the wound, and, tracing the course of the artery, tied both ends, the one in the popliteal space, the other in Hunter's canal. The limb was wrapped in wadding, and laid on a soft pillow; the wound dressed with tepid water, and afterwards with lotions. Ligature separated on the twelfth day. No hæmorrhage. Dismissed cured.

2. M. P., æt. 17, admitted 21st May. Two weeks previous to admission this patient received a wound in front of the right elbow-joint, from a piece of broken glass. The bleeding, which was very profuse, was arrested by cold, and by direct pressure. It recurred, however, twice the same week, and also on the day of admission. When brought to the hospital she was very anæmic, and had a small feeble pulse. Mr. Spence, on enlarging the wound, perceived a small puncture in the brachial artery, just above the point of bifurcation, from which blood issued when the tourniquet was relaxed. The vessel was tied above and below the opening. The ligatures separated on the fourteenth day. The patient made an excellent recovery.

3. Mrs. F. was admitted 22d April, with an incised wound over the course of the right ulnar artery, a little above the wrist-joint. The hæmorrhage, which was profuse at the time, had ceased. On separating the lips of the wound, however, and sponging it out thoroughly, the blood jetted through a small opening which had been made in the vessel. A double ligature was applied, and the limb laid on a Gooch's splint. Dismissed cured.

4. D. S., while at work in a quarry, was struck by the sharp edge of a spade on the outer side of the left wrist. The radial artery was divided in the hollow between the phalangeal extensors of the thumb. Both ends were searched for and tied. Cured.

5. M. H., a nurse in the surgical wards, had the right radial artery divided in the lower third, by a piece of a soda-water bottle, which burst while she was drawing the cork. Mr. Spence, who was in the wards at the time, immediately secured the vessel above and below. Erysipelatous

inflammation attacked the hand and forearm, ending in suppuration on the back of the hand. Cured.

6. J. V. received a deep punctured wound in the textures lying between the metacarpal bones of the thumb and fore-finger. The wound bled considerably at the time, and on three subsequent occasions the bleeding issued from the bottom of the wound as if the radial had been opened into. On admission—there being no hæmorrhage—pads were placed on the radial and ulnar vessels at the wrist, also on the wound, which was on the palmar surface, and on the dorsum directly opposite. The pads were secured by bandaging, the limb elevated and the elbow flexed. After this there was no recurrence of hæmorrhage. Cured.

7. W. B., æt. 45, a brewer, received a punctured wound over the ulnar side of the superficial palmar arch. The patient was admitted a week after receipt of the injury, on account of repeated attacks of hæmorrhage. Pads were placed over the vessels and wound, as in the case of J. V. Bleeding did not recur, but acute inflammation set in afterwards along the course of the synovial sheaths of the muscles of the forearm, terminating in suppuration. The matter was evacuated by a deep incision a little above the wrist. Dismissed cured.

8. A child, aged eighteen months, had received a wound of the radial artery in the lower third of the forearm eight days before it was brought to the hospital. The bleeding had been arrested at first by a compress and bandage, but repeated hæmorrhage had occurred. The infant was much exhausted. The pressure had caused sloughy ulceration of the wound, and there was considerable inflammatory thickening and an erythematous blush on the surrounding skin. It was evident, however, that ligature was imperative, and I therefore enlarged the wound upwards and downwards, and cleared the artery above and below, so as to tie it where the coats were still healthy. Simple tepid-water dressing was then applied. Everything went on favourably : the ligature separated on the seventh day without any hæmorrhage, and the wound contracted and healed rapidly.

This case affords an instructive example of the danger of trusting to compression, instead of tying the wounded vessel at once, especially in the case of a child, where the integuments soon ulcerate under firm compression, and where the loss of even small quantities of blood is so dangerous. Moreover, the effects of compression always render the vessel less fitted for ligature, and the operation, so simple if performed in the first instance, is rendered difficult from the inflamed, adherent, and altered character of the surrounding parts ; and if the ulcerative action continue in the wound, the risk of secondary hemorrhage is considerable. Fortunately, in most cases, as in this, the ulceration ceases after ligatures are applied, when compression is no longer necessary.

Remarks.—Even in recent surgical works, a rule is laid down that in primary hæmorrhage no attempt should be made to tie the wounded artery unless it be bleeding. This law is certainly very applicable to small bloodvessels to which there is no direct

guide, and which may be generally trusted to nature and compresses. But where the artery is of such a size as the radial or larger, there is no security from hæmorrhage without ligature or acupressure of the vessel; and if from the position and direction of the wound it be suspected that the arterial trunk has been opened into, the incision should be enlarged in the direction of the course of the vessel, and a ligature applied, if necessary. Two of the above cases illustrate this modification of the rule,—the one shows the necessity of a careful examination of the wound, and the early application of the ligature; the other indicates the risks arising from delay. In C. C., the wound looked at first sight trifling. It was situated rather low down in the thigh to lead to the suspicion that the femoral was opened into, and, but for the blanched appearance of the child, and the mother's statement that there had been a great loss of blood, the real danger might have escaped observation. In order to examine the injury thoroughly, the patient was placed under chloroform. On inserting the finger into the wound, it was found to pass obliquely upwards, and on tracing the lacerated tendon of the adductor, the sartorius was felt divided, and the end of the femoral artery pulsating in Hunter's canal. In addition to this, a large accompanying vein was torn across, and the shaft of the femur was laid bare at the seat of injury.

Although under these circumstances there was great liability to gangrene of the limb, it was not deemed proper to adopt severe measures in the first instance, inasmuch as the patient was young, the bruising of textures limited, and there was no great effusion of blood to compress or prevent the collateral circulation. The wound was, therefore, extended in the direction of the course of the main vessel, and one end secured in Hunter's canal; the other, which had retracted into the popliteal space, was followed and tied. The recovery of the patient was uninterrupted and complete; but if the rule stated above had been neglected, there is every probability that on the restoration of the natural force of the circulation, the clot would have been broken down, the hæmorrhage been repeated,

and the already exhausted child have succumbed under the further loss of blood. In the second case, M. P., a wound of the brachial artery was treated in the country for two weeks with compresses and bandage ; but during that time there had been repeated attacks of hæmorrhage which greatly exhausted the patient, and the wound had assumed such an unhealthy appearance that it was impossible to continue the treatment. From the position of the wound over the bend of the arm, and from the occurrence of repeated bleedings per saltum, there could be little doubt that the brachial was opened into. In order to tie the bleeding vessel, the incision was extended, and the infiltrated textures separated by the finger. The round tendon of the biceps was then felt to be completely divided, and the semilunar fascia stretched and nearly entire. I divided the fascia over the artery, and broke down the recent lymph. After this, when the tourniquet was relaxed, blood was seen to issue from a puncture in the side of the brachial just above the bifurcation. A ligature was therefore applied above and below the opening. The arm was kept in a flexed position, in order to promote the union of the biceps. After this there was no recurrence of the hæmorrhage. In this patient the operation was much more difficult than in the former, on account of the infiltrated state of the tissues, and the great difficulty experienced both in separating them and in recognising the various textures.

Two instances of suspected wound of the palmar arch (J. V. and W. B.) were admitted some days after receipt of the injuries. As the patients were strong men, and little affected by the hæmorrhage, there was no great risk from bleeding, so long as they were under direct observation. Compresses were therefore placed directly over the wound and over the radial and ulnar arteries, and secured by a firmly-applied bandage. This, combined with flexion and elevation of the limb, proved sufficient to prevent further hæmorrhage. If bleeding had supervened, it would probably have been impossible to apply a direct ligature to the wounded vessels, and failing this, it would have been necessary to cut down and tie the brachial.

Case of Ligature of the Axillary Artery for Hæmorrhage resulting from a Burn of the Arm.

David Henderson, æt. nine years, met with a severe burn of his left arm, on the 20th December 1845, owing to his clothes taking fire.

In the absence of Mr. Kerr, the usual medical attendant of the family, another medical gentleman dressed the wound with cotton wadding ; but owing to the offensive smell of the discharge, and in order to see the full extent of the injury, Mr. Kerr removed this after some days. He then found that the true skin was very severely injured, and that the burn extended from the lower part of the axilla to near the hand, and in the upper arm that it was chiefly situated towards the inner side.

Stimulating applications and poultices were then used, and in a short time sloughs separated from the injured surface above and below the bend of the arm, and the sore healed kindly enough at several points. At the bend of the arm, the sloughs were very deep and long in separating, and Mr. Kerr watched their separation with considerable anxiety for fear of hæmorrhage taking place.

On the evening of the 6th of January 1846, a portion of slough came away, and was followed by considerable loss of blood. Mr. Kerr and Dr. Duncan saw the boy shortly after this, and as the bleeding was then evidently venous, they arrested it by bandaging from the fingers upwards, and placing a graduated compress over the bleeding point. This completely arrested it until the evening of the 8th January, when a deeper portion of slough separated, and sudden and profuse hæmorrhage took place. Mr. Kerr attended almost immediately, and seeing that the bleeding was now arterial, arrested it by compressing the humeral till I arrived, but the child had already lost a very large quantity of blood. On examining the arm, the whole extent of the limb, from the lower margin of the axilla to the hand, exhibited the effects of the burn, being raw and discharging freely. On removing a piece of lint from over the bend of the arm, a deep cavity was exposed, and at the bottom of it the brachial artery was seen, with a small oval opening in its anterior wall. When the pressure on the brachial was relaxed, a jet of blood came from this opening, so as to leave no doubt as to the source of the hæmorrhage. From the appearance of the opened vessel, and the sloughing state of the surrounding parts, I considered it improper to trust to ligature immediately above and below the opening ; whilst the state of the arm, together with the impaired vitality of the skin and other tissues, rendered ligature of the brachial in the middle, or higher in the arm, equally unadvisable. I therefore determined to tie the axillary in the third portion of its course, where it lies on the tendon of the latissimus dorsi, and with this view the arm was separated from the side, and extended as far as could be done under the circumstances.

I made an incision about 2½ inches long, commencing about an inch and a half within the anterior margin of the axilla, and carried down along the inner edge of the coraco-brachialis ; the fascia was divided to the same extent, and the plexus of nerves brought into view. I next separated the median and internal cutaneous nerves, and exposed

the vessel, and, after carefully clearing it, passed a ligature round and tied it. There was a good deal of troublesome oozing of blood during the dissection, owing to the raw and vascular state of the skin at the lower part of the incision, and considerable delay and annoyance were caused by the unmanageable state of the patient (who, I should have mentioned, was deaf, dumb, idiotic, and epileptic). At the commencement of the operation, he thought proper to amuse himself by blowing out the candle, and when I was about to pass the ligature round the artery he took an epileptic fit.

After the vessel was tied, the edges of the upper part of the wound were brought together by points of suture, and the ligature allowed to hang out at the lower part. After waiting a short time, slight bleeding was noticed to take place from the lower part of the opening in the brachial artery. I therefore placed ligatures above and below the opening, as compresses seemed to give rise to much irritation, and as I trusted there might be sufficient vitality of the coats of the vessel there to sustain the ligatures for a day or two till more permanent changes at the part, and in the collateral circulation, had taken place. The burned surface was then dressed with a stimulating lotion.

Next day I found that the patient had passed a very restless night, constantly moving the injured arm, but no further bleeding had taken place. On the evening of the 11th January, the ligatures above and below the opening in the brachial artery came away, but no more hæmorrhage took plaae. The ulcerated surface at the bend of the arm healed kindly.

The edges of my incision at the lower part, where it had reached the injured skin, looked sloughy; but the upper part of the incision, corresponding to the point where the vessel was tied, had united, and I removed the stitches. As the patient still continued restless and unmanageable, constantly moving the arm and disturbing the dressings, it was found necessary to muffle the opposite hand and secure the injured arm towards the side. The sloughy appearance of the lower part of the incision increased for some days, and gave me some anxiety. Stimulating dressings were applied to it, and, on the ninth day after the operation, a slough separated which relieved our fears, as it was found not to extend deeper than the skin, and the parts beneath were healthy in appearance; from this time everything went on well, in spite of the unfavourable nature of the case and the unmanageable state of the patient.

The ligature from the axillary came away on the sixteenth day after the operation, and the incision healed rapidly. After this I did not attend him, but Mr. Kerr informs me that cicatrisation of the whole surface was not effected until the end of February, and that now the contraction of the hand and forearm towards the shoulder is very great. He also mentions that, strangely enough, the first time the boy was left alone he ran to the fireplace (fortunately empty), and thrust his injured arm between the bars of the grate.

Remarks.—In this case it will be observed that, whilst the injured vessel was situated, as regarded retrograde bleeding,

much in the same circumstances as an artery wounded by a cutting instrument, it differed from it in this material point. The vitality of its coats was impaired, and these partook of the weakened action of the surrounding parts from the effects of the burn, so that I could not have trusted to ligature above and below the opening, because the action of the ligature on the vessel would have proceeded too rapidly, and the impulse of the circulation would, in all probability, have caused secondary hæmorrhage in a day or two, on the decidence of the ligature. On the other hand, ligature of the arterial trunk higher up, whilst it would have arrested the flow of blood from the upper part of the vessel, would not have sufficed to arrest the retrograde bleeding. I therefore adopted the practice of tying the main trunk high up, where it was healthy, and situated amongst healthy parts, in order to divert the impulse of the blood from the canal of the wounded vessel. The ligatures above and below the opening at the bend of the arm prevented the retrograde bleeding sufficiently long to allow of consolidation of the surrounding textures, and permanent obliteration of the vessel, obviating the necessity for bandaging and compresses. The necessary dressings to the general burned surface were not interfered with. Of course the nature of the agent causing the sloughing must be taken into consideration, as this may materially influence the line of practice.

Whilst writing out these remarks, I was called to a young gentleman in the country, who, by applying nitrate of silver over the course of the radial artery, had opened that vessel. The eschar separated whilst he was out shooting, and he had lost a very large quantity of blood. In this case I merely cut down upon and tied the vessel a short distance above and below the wounded point, because I knew that the adjacent structures, after the separation of an eschar caused by nitrate of silver, are generally in a state of healthy action, and not in that condition of impaired vitality which characterises the tissues implicated in a severe burn by fire.

Case of Hemorrhage from Sloughing of the Brachial Artery after Severe Gunshot Wound.

John D., æt. 34, residing at Newlands. Admitted 17th October 1867.

From the rambling statement of the patient, whose intellectual faculties seem in some degree impaired, it would appear that, when out poaching on the night previous to his admission to the hospital, he engaged in a quarrel with another poacher. A struggle between them ensued, during which one of the guns went off close to the patient's left side. He was brought to the hospital on the morning of the following day. On examination, it was found that a large portion of integument on the lower and inner side of the arm, immediately above the elbow, had been carried away by the contents of the gun. The tendon and part of the muscular tissue of the triceps were torn off, while parts of the brachialis anticus and biceps muscles were laid bare. A large portion of the ulnar nerve was wanting. The median was exposed for about an inch, and close beside it the large brachial trunk was seen to pulsate, apparently, however, uninjured; but one of the venæ comites was opened. There was great laceration of the skin and deeper-seated textures, but the bone was untouched. It was decided that amputation was not imperatively called for, and that, with rest and proper treatment, a useful limb might be saved.

Oct. 18.—Patient feels very little pain from the arm. Wound looking slightly sloughy. Pulse 106.

Oct. 23.—Wound sloughy. Tongue coated. Pulse 124.

Vespere.—Hæmorrhage occurred from the wound about 5.45 p.m., but was immediately arrested. Mr. Spence was sent for; and, finding that the bleeding proceeded from the brachial artery, he cleared the vessel and tied it above and below the opening. Very little blood was lost.

11 p.m.—Temperature of the hand and fore-arm equal to that of the opposite arm. Faint pulse at the wrist.

Oct. 24.—At a consultation to-day, Mr. Spence's opinion (that no interference was at present required) was agreed to.

Oct. 25.—Radial artery at wrist quite perceptible. Pulse 120.

Oct. 26.—Pulse 130. Considerable sloughing taking place at lower and inner part of wound, but quite healthy near the artery.

Oct. 29.—Greater part of slough separated. Wound looking clean. Pulse 132.

Nov. 3.—Going on well. Pulse has gradually come down to 102. Ordered four ounces of port wine.

Nov. 10.—Still improving. Pulse 96. Ordered ammonio-citrate of iron.

Nov. 16.—Wound dressed with red lotion, and gentle support given with a flannel bandage. Patient allowed to rise.

Nov. 23.—This morning the back of the little and ring fingers of left hand are covered with large blisters. (The weather is intensely cold.)

Nov. 28.—Small sloughs have separated from the fingers.

Dec. 19.—Wound of arm contracted to about the size of a shilling. The little finger is now quite well. Other fingers nearly so.

Dec. 24.—Both fingers now well.

Dec. 26.—There is a vesication as large as a fourpenny piece on the ring finger, and another of the same size on the point of the little finger.

Jan. 3, 1868.—Patient having gone on steadily improving, was allowed to leave to-day.

Remarks.—This case had many points of interest considered as a gunshot injury, but I refer to it at present in reference to the hæmorrhage which occurred from sloughing of the brachial artery. On being summoned to see the patient, I found a small clot of blood over the part corresponding to the site where the artery had been exposed, and this clot moving with each pulsation of the vessel. But, recollecting that one of the venæ comites had been wounded, and that possibly the easily-arrested bleeding might have been venous, I caused Dr. Yellowlees to compress the brachial at the upper part of the arm, and then, having brushed away the clot, I desired him to relax his compression, when the full jet of arterial blood at once settled all doubt as to the nature and source of the bleeding. I then dissected along the course of the vessel, so as to clear it at a healthy point not too far removed from the opening. As the parts were matted and sloughy, and the vessel flaccid from being compressed above, some difficulty might have been experienced in recognising and clearing it, especially on the distal side of the opening, but for the simple and old-fashioned expedient of gently introducing a common probe through the opening into the canal of the artery, so as to render it perfectly distinct and easily cleared and secured.

The occurrence of secondary hæmorrhage from a large arterial trunk implicated in an incised wound, however matted the surrounding parts may be by inflammatory action and previous attempts at compression, would scarcely induce any surgeon in the present day to think of amputation. But here the case was more complicated; for not only was the original wound such as rendered the prospect of saving a useful limb somewhat problematical, but I knew positively that two of the most important collateral branches—namely, the inferior profunda and anastomotica magna—were destroyed; and hence the anastomoses, on which

we depend for carrying on the circulation to the parts beyond the ligature, seriously interfered with. I confess that at first I merely looked to the ligature as a temporary measure to save immediate loss of blood, and allow the patient time to rally before amputating; and, as the case was likely to be a medico-legal one, I directed a consultation to be called for the next morning. However, on my visit late at night, I was agreeably surprised to find the hand of a good temperature, and a distinct, though feeble, pulse in the radial artery of the injured limb. Next morning the pulse was quite distinct, and the condition of the limb, as regarded the fully re-established circulation, such as left little room for difference of opinion as to persevering in conservative treatment.

I think that scarcely any case could better illustrate how much we may trust to vascular supply, even after many of the larger anastomoses are cut off. And when we consider the sloughy state of the wound, the impaired nervous supply from division of the ulnar nerve, and the swelling from exudation, which, to a certain extent, would press upon and obstruct the smaller vessels, together with the debility of the patient from the great loss of blood at the time of the accident, no case could well appear less favourable as regarded the prognosis.

Acute Necrosis of Fibula; Hæmorrhage; Ligature of Superficial Femoral; Recurrence of Hæmorrhage; Amputation; Recovery.

Mr. A. T., aged 23 years, residing at East Linton, came under my care on the 15th of August 1862, on account of acute necrosis of the fibula, which had begun about the middle of July 1852. On Thursday the 9th September, as his general health was suffering severely, I proceeded to remove the diseased bone.

Dr. Hislop having administered chloroform, I passed a probe-pointed bistoury down to the bone, through the incision over the middle of the fibula, enlarged the opening upwards and downwards to the extent of $5\frac{1}{2}$ inches, and extracted a long sequestrum, consisting at one part—of about an inch in length—of the whole thickness of the bone. I next enlarged the upper incision to the extent of three inches, and extracted another sequestrum, but some small portions seemed still attached to the head of the fibula. There was no great amount of bleeding, and the wound was

dressed with dry lint, and supported by a moderately tight bandage. I saw him again on the Saturday, and dressed the wound ; there had been no oozing after the removal of the dead bone, and the wound was looking well. As I happened to be residing in the neighbourhood for a few days, his brother called on me on the Monday forenoon following, and told me that he seemed much easier, and in better spirits than for some time back. About ten P.M., however, I received a message from his brother, stating that on reaching home he had found that alarming bleeding had occurred about a quarter to nine P.M., and that Dr. Hislop wished me to come immediately to the case.

I accordingly went, and reached the patient's house about half-past eleven P.M. He had by that time somewhat recovered from the first effects of the loss of blood under the use of stimuli, but was nervous and excited. I learned that the bleeding had taken place slowly and unnoticed until he felt sick. He was talking with his mother and sister at the time, and on his complaining of faintness, they happened to look at the bed, which they found covered with blood. Dr. Hislop was sent for, and arrested the bleeding by pressure. Having applied a tourniquet over the femoral artery, I cut up the bandage, and found the leg more swollen than when I last saw it, as if from coagula. I accordingly removed the lint from the large incision in the leg, with my finger removed the coagula, and then with a sponge cleared the large exposed surface. The edges of the wound being held apart, I directed the tourniquet to be gradually slackened till all compression was taken off the femoral. No jet of blood was noticed. I again examined the wound with my finger, and as the lymph seemed firm, I placed slips of lint into the deep part of the wound, and then a larger compress, and secured them by a roller applied from the toes upwards. An opiate was then given to procure sleep.

I remained at his house all night, and at nine o'clock, before I left for Edinburgh, I saw him with Dr. Hislop. There had been no recurrence of the bleeding. I was still suspicious, however, from the amount of blood lost, and the long-continued diffuse suppuration which had previously existed, that the fibular artery might have been disorganised and given way from sloughing. I accordingly came back from town as soon as I could, and on reaching Linton I found that bleeding had just recurred to a considerable amount. Assisted by Dr. Hislop and my friend Dr. Littlejohn, who had accompanied me, I again examined the wound. The extent of the incision enabled me to see the whole deep part of the wound, on clearing which of coagula, I found the textures generally covered with firmly adherent lymph, but some of the deeper parts looked sloughy and unhealthy. The bleeding welled up from the surface of the wound, but not in a jet. The patient's state demanded that some decided measures should at once be adopted, since direct graduated compression had failed. As to direct ligature on the bleeding point, although I suspected the fibular artery, yet, though the large incision exposed the surface of the wound fully, there was no jet or distinct indication of bleeding from any one point, whilst the disorganised sloughy condition of the deep surface of the wound rendered it more than doubtful that a vessel, even if discovered, would have held ligatures. There remained, therefore, only the alternatives of ligature of the femoral artery, or amputation. The latter,

from the state of the patient and the extensive suppurating surface, might ultimately be necessary even for other reasons ; but I was very unwilling to sacrifice the limb, and, moreover, from the faint condition of the patient at the time, he would not have been able to bear the operation. I therefore determined to tie the superficial femoral, in order to control the general circulation of the limb, and to assist it by moderate graduated pressure directly applied to the wound. The patient having been brought under the influence of chloroform, I at once proceeded to tie the vessel, which was readily accomplished without removing the patient from bed. All oozing from the wound ceased immediately. Some lint was placed over the wound, supported by a thin flannel roller lightly applied. On the second day after tying the vessel I saw him again. He was much better, the wound looked healthy, and everything seemed to promise well, as the circulation in the anterior and posterior tibial arteries was fully re-established. All went on well till the 21st September, when I was sent for in the afternoon, as bleeding from the leg had again occurred. I found the patient recovered somewhat from the first effects of loss of blood, which had not been to a large amount ; but I felt I could no longer persevere in attempts to save the limb, as any farther bleeding might have proved fatal, since the deep part of the wound was still sloughy, a portion of the necrosed fibula close to the knee had still to separate, and the patient was exceedingly debilitated from the previous exhausting disease, as well as from the hæmorrhage. It was decided to amputate the limb at the lower part of the thigh. I had foreseen that this usually simple operation would be complicated in this case, both on account of the greater number of vessels which would require ligature in consequence of the enlargement of the collateral branches after ligature of the femoral, but especially from risk to the deligated artery itself, by any traction exercised on it during the operation, as it was about the period when the ligature begins to separate by ulceration, and accordingly I had obtained the assistance of my friends Dr. Handyside and Dr. Littlejohn. Dr. Hislop administered chloroform, and as soon as the patient was under its influence he was carefully turned round, and drawn towards the edge of the bed, and the limb steadily supported.

Dr. Handyside having compressed the common femoral, I removed the limb by double flap above the knee. The mouth of the superficial femoral was readily recognised, but I first secured the enlarged collateral branches, which could not be so completely commanded by compression. Before tying the superficial femoral, Dr. Handyside, at my request, relaxed the compression somewhat, and blood flowed from its mouth, but, as might be expected, not in a jet. It was then tied ; the flaps were approximated by sutures, and the stump was dressed. There was little blood lost during the amputation, but the patient was very weak, and it was some time before he fully rallied under the use of stimuli, and he required careful watching during the night to prevent the circulation flagging ; indeed Dr. Littlejohn and I watched him constantly. Towards morning reaction became fairly established, and he took some food ; an opiate was given him, which procured him some refreshing sleep. I returned to town, but took the precaution of leaving my senior apprentice, Mr. Rhind, in constant charge, in case of accident, till the femoral ligature

came away, as Dr. Hislop of course was often engaged with cases at a distance. At first the stump healed very rapidly, except where the ligatures hung out. The ligature of the superficial femoral separated on the fifteenth day from the time it was applied, or about eight days after the amputation. Subsequently the patient suffered from irritation of the bowels, and one or two attacks of general erythema supervened, beginning on the face, and spreading over the trunk and stump, but gradually, under the use of the tincture of the muriate of iron, and attention to diet, his general health began to amend, and then the stump healed well. Last summer he was in perfect health, and able to walk considerable distances, and still continues, he says, in better health than for many years before his illness.

Dissection of the Limb.—I carefully examined the amputated limb the morning after the operation. I found all the textures covered and matted together with firmly consolidated lymph, so that on removing the gastrocnemius and soleus muscles, no trace could be seen or felt of the posterior tibial vessels and nerve, or of the fibular artery. To avoid all risk of accidental lesion of these vessels during dissection, I cleared the popliteal artery, and being unprovided with a syringe, I passed a long probe gently downwards, so as to guide me in the direction of the vessels. By very careful dissection I cleared the upper part of the posterior tibial artery, and in doing this I came upon a soft and sloughy portion of lymph, which readily broke down under the handle of the scalpel, and proved to be part of the cyst of a small abscess or cavity about the size of a large filbert, containing pus and grumous blood, in which a portion of the fibular artery lay insulated, and of a dirty green colour. I withdrew the probe from the posterior tibial artery, and passed it gently into the fibular. There was no opening on the posterior surface of the vessel, or that towards the wound. I therefore made an incision so as to remove a considerable portion of the vessels and surrounding soft parts, so as to be able to examine it more carefully afterwards. On doing so I found the vessel immediately above and below the small cyst or abscess encrusted (if I may use the term) with firmly adherent lymph. This lymph was continuous with that which formed the walls of the abscess, and opened anteriorly by an irregular ulcerated orifice. On enlarging this opening, so as to expose the anterior surface of the peroneal artery, and, on injecting water from the popliteal, a hair-like stream was seen to issue from the forepart of the fibular artery. I then removed the whole anterior portion of the cyst, and found the peroneal artery perforated by a minute ulcerated opening, large enough to admit a bristle. The coats of the vessel, however, were soft, thin, and of a greenish colour, and completely insulated for about an inch, whilst beyond the insulated part the tunics of the vessel were inseparably incorporated with the lymph, so as to defy all attempts to clear the vessel by dissection. Some small necrosed portions of the fibula still remained attached at its upper part.

Remarks.—The principal point of interest in this case is the complication caused by the occurrence of hæmorrhage from the ulceration of the fibular artery, in consequence of its being

isolated by the suppuration around it. At the same time, to form a correct view of the treatment adopted, it is necessary to keep in mind all the circumstances of the case; for the previous debilitated state of the patient, from the long-continued irritative fever, the subsequent profuse discharge, hectic, and general exhaustion, together with the disorganised and altered condition of the structures of the affected part of the limb, were all complications requiring to be carefully considered in deciding on the measures to be adopted when the secondary hæmorrhage occurred.

I have said that I suspected that the bleeding might come from the fibular artery, from the relative position of that vessel to the diseased bone and the unhealthy suppuration around. Hence my first object was to try and secure the vessel directly at the bleeding point. But, on examining the exposed surface, which the extensive incision in the leg readily admitted of, there was no jet of blood or other indication to guide me, while the altered condition of the structures in the wound, the matting together of some parts, and the sloughy condition of others, caused me to desist, as I felt that, under such circumstances, without some direct indication of bleeding, a tedious dissection would be required to reach the vessel, with no certainty of reaching it at the open point; and, after all, my surmise as to its being the fibular artery might be wrong. Again, if an opening in the vessel were found, its coats might be so unhealthy as not to hold a ligature above and below the opening. The subsequent dissection of the limb proved the difficulties of direct ligature to be even greater than I had anticipated. The portion of the vessel where the opening existed was surrounded by an encysted abscess, and had only bled indirectly into the wound; hence the reason that no jet could be observed on removing the pressure on the femoral when examining the wound. The arterial tunics, where they were isolated, were so soft and sloughy that they would not have held a ligature for a few hours, if at all; whilst immediately beyond the isolation the whole track of the vessel was so

incorporated with adherent lymph as even to defy its separation to any extent, by careful dissection, when removed from the limb. What probability, then, would there have been of treating the vessel by direct ligature?

As to the method of indirectly controlling the bleeding, by weakening the general circulation through the limb, by ligature of the superficial femoral, no one can be more impressed than myself with its uncertainty, as compared with direct ligature, owing to the free anastomoses in the thigh and around the knee, above the bleeding point. But when, for the reasons above stated, the latter could not be adopted, I considered it right to give the patient that chance, rather than amputate, as I had seen it succeed in cases of a similar character. I had likewise, by somewhat similar means, successfully arrested hæmorrhage from ulceration of the brachial from sloughing, after a severe burn, by tying the third portion of the axillary artery. It is true that in that instance I at the same time applied ligatures above and below the wound of the brachial; but these ligatures separated by ulceration on the fifth day, so that, except for the ligature of the axillary artery controlling the circulation, bleeding would have recurred. Hence I felt warranted in trying it in this case; and, indeed, there was little room for hesitation, for the patient was so sunk from the recent bleeding, as to put immediate amputation out of the question; and, as oozing was still going on and direct pressure had failed, something required to be done.

There can be no doubt, I think, as to the generally admitted propriety of giving preference to direct ligature above and below the opening in all cases of wounded arteries, as a great general rule, and it is one which can scarcely be too much insisted on; but at the same time we must keep in mind that there are exceptions to this, as to all other general rules, and that much must depend upon the state of the vessel opened. If its coats are diseased and sloughy, if their vitality and that of the surrounding parts be impaired, as after extensive unhealthy suppuration or severe burns, then direct ligature, if trusted to

alone, without controlling the force of the circulation by ligature on a healthy point of the vessel higher up, must often prove abortive, and repeated hæmorrhage from rapid ulceration of the deligated part of the artery be the result. In fact, everything depends upon the state of the arterial tissue in the neighbourhood of the lesion, and the probable destructive power of the agency producing it. I have instanced burns by fire; on the other hand, ulceration from caustics generally leaves the parts whence the slough has separated healthy, and, curiously enough, the very patient whose case I have just narrated nearly lost his life on a previous occasion from ulceration of the radial, caused by nitrate of silver applied to a bite. On that occasion I also saw him, but, knowing the limited action of the caustic, I exposed and tied the radial above and below the ulcerated point with success. But it would have been a very different matter in the sloughy condition of the fibular in the present instance, even if there had been any indication to guide me to the bleeding point. In the present case the ligature of the femoral did effectually prevent all hæmorrhage for a time; it allowed the patient time to rally; and when, on the circulation being fully established, the bleeding recurred, it was both less active and less in amount, and, had the patient been even tolerably strong, I doubt not but that moderate and regulated pressure might have ultimately succeeded in arresting further hæmorrhage. But, debilitated as he was by the previous exhausting disease and the repeated bleeding, and peculiarly depressed by the fear of hæmorrhage from a remembrance of the risk he formerly ran, I felt that even a very trifling loss of blood might prove fatal, and the danger to life seemed so great as to forbid any further attempts to save the limb.

Injury of the Axillary Artery from Fracture of the Neck of the Humerus.

Mr. J. B——, aged sixty-three, in coming down stairs from the drawing-room, tripped on the carpet, and fell down with his whole weight on the elbow and point of shoulder. I was sent for on the part of Dr.

Lawrie, who attended the family, and on examination I found the humerus broken at the neck, the broken end of the shaft considerably displaced inwards to the axilla, and the elbow tilted outwards.

Mr. B—— was exceedingly sick and faint, having only a short time previously recovered from a severe attack of rheumatic fever, and suffering at the time of the accident from bowel-complaint.

The fracture was readily adjusted, scarcely any force whatever being necessary to extend the shaft of the bone and withdraw it from the axilla. I put it up in the usual manner, with a soft compress in the axilla, placing the forearm in a sling, and confining the arm and elbow to the side by means of a broad soft shawl. I then ordered him an opiate to arrest the diarrhœa, and left him.

Next morning I saw him with Dr. Lawrie. He had passed a very restless night owing to the bowel-complaint, and also from pain at the fractured part, and numbness in the hand. On loosing the bandages, the hand and forearm were found not much swollen, but they were much colder than those of the opposite side, and no pulsation could be felt either in the brachial, radial, or ulnar arteries, at any point, but distinct and full pulsation could be felt in the axillary, immediately above the fracture; there was considerable ecchymosis and bruising over the point of the shoulder and deltoid, also some swelling along the inner side of the biceps, but there was no pulsatory movement in the swelling, nor any appearance of its communicating with the artery. It was evident, however, that the axillary had suffered, that circulation through it was obstructed, and that the treatment of the fracture must be considered secondary to that of the injury of the vessel. I accordingly did not replace the pad in the axilla, but got a soft cushion made sufficiently long to reach from the axilla to the hand, jointed at the elbow, and thicker above than below. This I placed on the inner side, and another soft cushion and thin pasteboard splint on the outer side of the arm and forearm. The elbow was kept only slightly bent, the splint and cushions secured with slip-knots, and the whole limb covered with flannel.

This plan, whilst it interfered but little with the restoration of the circulation through the collateral branches, kept the broken ends of the bone pretty well in position. I continued it for the first fifteen days, when, although I could feel no pulse in the larger vessels, I was satisfied, from the restored heat and sensation of the part, that the circulation was re-established sufficiently to allow of the ordinary apparatus being used. Accordingly, I replaced a soft elastic hair-cushion in the axilla, and a leather splint, well padded, along the outside of the arm and forearm (from the point of shoulder to the extremity of the fingers). The forearm was supported in a sling, and the arm kept to the side by a soft shawl.

Under this treatment the patient went on favourably, except that, about the end of third week, he complained much of severe pain in the part, and of a sense of suffocation, and a feeling of weight across the chest, which he attributed to the position of the forearm across the body. The sling was lowered so as to change this position, but still the feeling continued; alterative medicine was given with some relief.

As it became of great importance for him to get home to London at this time, and as the union of the bone seemed sufficiently firm to warrant

his removal, he left Edinburgh, with my consent, on the 17th of August. Since then I received the following accounts of his progress from his usual medical attendant, Dr. Bower of Hatton Garden, and subsequently from Mr. Liston, to whom I had requested him to apply, but whom he had not consulted till 1st October.

"As Mr. B—— has now been under my watching more than a month, I am able to give you an account of his progress more satisfactorily than if I had written sooner. The callus around the fracture is completed, and he begins to move his arm somewhat, and in time doubtless it will turn out all right. I cannot, however, say as much for the circulation through the forearm and hand. I can only distinguish a very faint pulsation in any artery beneath the fracture. At the wrist there is none either in the radial or ulnar, and therefore I suppose the circulation through the hand must be by means of the interosseous or carpal. As you may suppose, the hand is not properly supplied, and much colder and more useless than it otherwise would be. I have adopted gentle friction and warm clothing to remedy this, but I expect more benefit from time than from either.

"From this statement I think you will agree with me that, considering the severe nature of the injury, he is doing well; and as I do not perceive any symptoms of disease or aneurism in the brachial artery, I trust he will go on uninterruptedly to recovery."

"*October 1st*, 1847.—Yours, dated 17th August, only came to hand this morning.

"Mr. B——'s case is a very interesting one, and one that must have required anxious and careful management. It is a capital cure; there is pulsation in the brachial, and a certain thrill at the wrist; there is a good deal of œdematous swelling on the inside of the arm, and in the sheath of the biceps, but I can detect nothing wrong in the axilla; no tumour, no unusual beating; so far so good. I should not apprehend any formation of aneurism now."

Remarks.—The complication of fracture of the neck of the humerus, with the untoward injury detailed in the foregoing case, is fortunately of very rare occurrence, and I cannot help attributing it, in the present instance, more to the state of the vessels in this gentleman, than to the effects of direct injury of the artery by the broken end of the bone; in other words, I consider that the internal and middle coats of the vessel, softened and altered in structure by the previous rheumatic affection, had given way, at the time of the injury, from indirect violence, whilst the cellular coat had been stretched and twisted so as to obstruct the flow of blood through its canal. I am led

to this conclusion by the following circumstances in the case :—1st, There was no unusual swelling or appearance of extravasation in the axilla at the time of the accident, as would have occurred had a large vessel been torn through by the sharp fractured end of the bone. 2d, Though the displacement of the shaft was considerable, it was not greater than I have frequently seen in fracture of the neck of the humerus, and, owing to the faintness of the patient, there was little or no force required to extend it, and produce coaptation. 3d, No false aneurism has subsequently formed, which would also have probably been the case had all the coats of the artery been torn by the broken end of the bone.

Mr. B—— lived for many years after the accident. He perfectly regained the use of the arm, but the circulation in the brachial, radial, and ulnar arteries always continued very weak, the pulse being scarcely perceptible ; but the limb seemed well nourished and of fair temperature.

Injury of the Brachial Artery in a Case of Simple Fracture—Amputation.

David B., æt. 6, was run over by a light van, and sustained a simple fracture of the humerus. The case was seen immediately on admission by Dr. Broster, now of Southampton, who was then (1860) my resident surgeon. The fracture was easily reduced, but the limb was noticed at the time to be very cold ; but as the temperature of the whole body was low from the effects of shock, Dr. Broster advised the friends to leave the child in the hospital to be watched. This the father refused to do, but promised to bring the child to the hospital next day. Dr. Broster, accordingly, after adjusting the fracture, enveloped the limb in wadding, and applied splints, but was careful to bandage very lightly.

The father brought the boy to the Infirmary next day, when I found the injured arm quite cold, livid, and pulseless—whilst the general circulation was re-established of course by this time.—There was no fever present. The limb lay straight, and showed only a little swelling on the inner side. The father could not be convinced of the necessity for amputation, but consented to leave the boy in the hospital. The splints were removed, and the limb simply wrapped in cotton wadding. Next day the discoloration of the hand and commencing decomposition convinced the friends of the true state of matters, and I amputated the arm immediately below the tuberosities of the humerus. The little fellow recovered without a single bad symptom.

Remarks.—On dissecting the limb, the brachial artery was found to be torn across at the point corresponding to the fracture of the humerus ; a sharp point of the bone seemed to have caused the injury. There was some extravasation along the course of the vessel on the inner side of the arm, but it was limited and flattened by the fascia, so that there was not much apparent swelling during life.

The occurrence of lesion of an artery in cases of simple fracture is not common, but the foregoing case, and that of Mr. B., show that it may occur ; and this risk forms one of my objections to the use of the stucco or starch bandage in the early stage of fracture. Had such treatment been adopted in this case, the gangrene would have spread unnoticed till too late to admit of successful interference.

CLINICAL CASES

ILLUSTRATIVE OF THE TREATMENT OF ANEURISM.

Case of Subclavian Aneurism, in which the Arm was Amputated at the Shoulder-joint.

On the 22d of March 1864, Mr. F. T., engineer on board H.M.S. ——, was placed under my care on account of aneurism of the right subclavian.

He informed me that about the beginning of 1860 he was under the necessity of doing some hard work with large heavy hammers. After his exertions he was much troubled with pains in his right shoulder, which were considered rheumatic, and treated as such in an hospital, to which he was confined for five weeks.

The pains were then so severe that he could not move the arm from the side, without suffering the greatest torture. He recovered to a great extent, but never was able to use his arm at all freely without experiencing pain shooting down the arm and round the shoulder.

These pains were often present when the arm was at rest, and there were exacerbations at frequent intervals.

Six months before I saw him, the arm began to feel cold and numb, and the ring and little fingers became insensible ; in which state they continued until his admission. Fourteen days before he came to me, he for the first time became aware of the existence of a swelling at the root of the right side of the neck. On examining him I found a pulsating tumour commencing in the interval between the two heads of the sterno-mastoid, extending outwards, and occupying the whole subclavian space ; there was also more pulsation than usual below the clavicle.

The right radial pulse was almost imperceptible, the right arm cold, numb, and somewhat œdematous ; the hand was purple and mottled ; the veins of the arm, shoulder, and right side of the neck were engorged.

Shooting pains were almost constantly felt in the arm. A distinct aneurismal *bruit* was heard over the tumour with the aid of the stethoscope. No further appreciable disease could be detected in the heart or great blood-vessels. The lungs were healthy, with the exception of a liability to frequent but slight attacks of catarrh. His general health had, however, been somewhat impaired by service on the west coast of Africa. Tongue was slightly furred. Appetite pretty good. Bowels regular. Pulse 72, of very fair strength in the healthy arm. Urine normal. His complexion was sallow and bilious-looking.

I had him placed in a private ward, and directed the limb to be wrapped up in cotton wadding, and supported in a sling ; and ordered him occasional doses of rhubarb and potash, with citrate of magnesia.

The cotton wadding raised the temperature of the arm several degrees, but the pain, though it abated when the patient was kept at rest, frequently recurred in severe paroxysms.

After careful consideration and consultation, I decided on amputating the arm at the shoulder-joint, and with that view had him kept quiet in bed for several days previous to the operation, which I performed on April 6.—Cutting from without inwards, I dissected a large flap, comprising the greater part of the deltoid, and then disarticulated, bringing the knife out, so as to divide the remaining soft parts, thereby allowing the main artery to be compressed before its division, as the circulation through the subclavian could not be commanded. The enlarged anastomosing branches bled very freely. After securing all the smaller vessels with ligatures, I cleared the axillary artery, with a view to tie it as near the aneurism as possible ; but, on reaching the lower border of the pectoralis minor, I found the vessel dilate so suddenly, and its coats to be so thin, that I deemed it unsafe to clear it further, and therefore tied it at that point. The edges of the wound were brought together with silver sutures, and an opening left for discharge at the lower angle. The patient was then placed in bed, an opiate was administered, and external warmth applied.

During the afternoon and evening there was severe vomiting from the effects of the chloroform, which was very ill borne by him.

Ice, brandy, and soda-water were given, and mustard applied to the epigastrium ; in the evening $\frac{1}{2}$ gr. of morphia was given in the form of suppository. *Evening pulse*, 108. *April* 7.—He had very little sleep during the night, owing to the vomiting, which continued at intervals during the night and following day. Pulse 120, rather weak. To have $\frac{1}{2}$ a gr. of morphia in a suppository, and 3 oz. of wine daily. *April* 8.—Vomiting ceased. Slept very badly ; copious discharge from stump. Tumour in neck is not more than half the size which it was previous to the operation. Pulse 124. Opium pill at bedtime, with two Colocynth and Hyoscyamus pills, to be followed by an enema in the morning, as the bowels have not been moved for three days. *April* 9.—Slept pretty well. Tongue furred ; pulse 100 ; bowels freely moved ; a little erythema at the lower edge of the wound ; two stitches removed. To have white of egg and milk as a drink. *April* 10.—Slept well ; pulse 98, of improved strength ; cramps frequently felt which were referred to the lost arm ; more stitches removed, and hot fomentations applied to the stump. A large opiate at bed-time, on account of great pain in the stump. *April* 11.—Pain abated. The tumour is now so small that it cannot be seen, and the feeling of pulsation is much diminished ; wound looking well ; more stitches removed. *April* 14.—All stitches removed ; there is a little bagging under the short flap, but the discharge has free vent ; pulse 86 ; tongue slightly furred ; appetite improving. *April* 17.—Doing well ; stump looks healthy. *April* 18.—Tongue rather dry in the centre ; pulse 82 ; complains of great pain and numbness in the stump ; discharge copious and healthy ; wound dressed with chlorinated soda lotion. A small counter-opening was made in the short flap, and a considerable quantity of pus evacuated. *April* 20 (14th day).—Two ligatures separated ; discharge from stump moderate and healthy ; pulse 82, of fair strength. *April* 21.—Three ligatures separated ; no hæmorrhage ; *April* 24.—Another ligature separated ; rather more pulsation is now perceptible in the tumour ; general health excellent ; wound healthy ; dressed with a lotion containing sulphate of zinc.

From this date the amputation wound continued to go on favourably ; the ligature on the axillary artery separated on the 7th May, and the rest of the wound was nearly healed. The aneurism was very much decreased, it was indeed, scarcely perceptible to the eye, though on examination the sac could be felt flaccid, and having very little pulsation ; but it did not feel as if consolidation by coagulation was taking place. His recovery was delayed by repeated attacks of bilious diarrhœa, which I at the time attributed to some hepatic affection contracted in warm climates, but which I afterwards learned arose from his own irregularities.

He was allowed to get up on the 18th of June. On the 24th of June the report is—" Since he left his bed the aneurism has perceptibly increased in size. Compression of the aneurism was begun to-day by means of a pad of lint placed over it, and secured by three long straps of plaster.

" *June* 30.—The pressure has produced no inconvenience. The aneurism is considerably smaller. His health is good. The stump looks well ; only one sinus now remains to be healed.

" *July* 5.—Ordered 5 grs. of iodide of potassium thrice a-day, to be gradually increased to 20 grs. thrice daily. Compression still maintained.

" *July* 20.—He now takes 12 grs. of the iodide thrice a-day. Yesterday he was troubled with coryza-headache and abdominal pain, in consequence of which the iodide has been stopped for a few days. The tumour is decidedly smaller and harder.

" *July* 23.—Iodide resumed in 12-gr. doses, as the symptoms of iodism have disappeared. General health good.

" *July* 30.—He now sits up nearly the whole day. Compression has been steadily maintained without producing the slightest inconvenience. The aneurism is very decidedly smaller and harder. He is taking 14 grs. of iodide thrice a-day without producing bad symptoms, and he is in excellent health and spirits."

Mr. T. left Edinburgh shortly after this—having received his discharge from the service—and went to reside in one of the midland towns in England. I heard from him occasionally, and for about two years the accounts were favourable as to the aneurism in the subclavian region, but it never altogether disappeared. Disease of the vessels nearer the heart seemed to have supervened, and he died in the course of last autumn (1868). I could learn no particulars of his death, and I suspect that it was not a little accelerated by his own irregularities.

Remarks.—The points to which I would first direct attention in this case are the characters of the aneurism, and the general condition of the patient.

The position and extent of the swelling have been already noted. It was clearly an aneurism involving the middle and external thirds of the subclavian, and somewhat also the terminal part of the first portion ; and, from the strong pulsation at the upper part of the axillary region, though covered by the thick and powerful pectoral, I suspected that the first part of

the axillary was affected. As to its general characters, careful examination satisfied me that it was one of those elongated, ovoid, or fusiform dilatations of the vessel arising from an alteration affecting the contractile and resilient functions of the middle coat, and allowing of gradual dilatation and alteration of all the coats. As we very generally find in such cases, there was no hardness, or other symptom of coagulation ; the swelling was compressible, and it gave a peculiar feel to the compressing finger, as if a flaccid vessel with thickened coats was pressed upon. Now, in cases of aneurismal dilatation of this form, from the integrity of the internal tunic, there seems less tendency for the molecules of the blood to adhere to the sides of the sac, whilst the circulating fluid, rushing with equal force in all directions, acts more generally as a disturbing force, than in cases where we have ulceration of the two inner coats, with lateral dilatation of the fibro-cellular tunic. Hence the aneurism in this case was not very favourable for any treatment in which we had to trust principally to coagulation ; indeed the absence of this natural tendency to a cure is unfavourable to any plan.

The state of the patient's general health was not very promising. Although a powerful, muscular man, he had long been in service in an unhealthy climate, and had suffered from rheumatism, remittent fever, and hepatic derangement, whilst the nature of his profession as engineer in one of H.M. ships, together with concomitant circumstances, had rendered the state of his general health by no means favourable for an operation.

I now come to the consideration of the circumstances which determined me to make a trial of Sir William Fergusson's proposal.

The methods whose respective merits, or rather demerits, I had to consider were—1st, The Hunterian plan, by tying either the innominate or the first part of the subclavian. 2d, The direct ligature, by dissection towards the innominate, so as to enable an assistant to command the circulation through it, and then to open the aneurism, and tie the orifices entering the sac : the modification of the old method of operating recently revived

in some cases of axillary and inguinal aneurism. 3d, The Distal or Brasdor's method. And lastly, the method I adopted. —In regard to the first of these alternatives, the ligature of the innominate, or first portion of the subclavian artery has proved so uniformly fatal, even in favourable circumstances, that I could not venture to entertain any hope of success in my case.

Direct ligature by opening the sac, and tying the artery on each side of the aneurism, as has been done in some axillary and iliac aneurisms by Mr. Syme, was suggested. The circumstances in this case, however, were very different. In the case of axillary aneurisms, the circulation can be effectually controlled during the operation; but here, laying bare the innominate so as to allow an assistant to compress it between his finger and thumb, would have only imperfectly effected the object, it would not have controlled the reflux vertebral circulation into the sac; and even supposing the circulation controlled, the proximal ligature must have been placed on that portion of the subclavian where all its large branches arise, and consequently with almost a certainty of failure of the hæmostatic process. Moreover, the fusiform character of the aneurism was unfavourable to the chance of a healthy portion of artery being found on either side of the dilatation. The direct method, therefore, seemed to me quite inapplicable to a subclavian aneurism, such as this. I was, therefore, almost shut up, either to try Brasdor's method of tying the artery on the distal side of the sac, or to combine that with removal of the stimulus to vascular supply, by performing amputation at the shoulder. In this case I felt less difficulty in deciding on amputation, inasmuch as the state of the arm rendered gangrene imminent, both from interrupted circulation and venous engorgment; it therefore seemed probable that further interruption by tying the innominate, or ligature of the axillary by Brasdor's method, would lead to complete gangrene, and necessitate amputation. The plan proposed by Sir William Fergusson seemed to me to give the fairest chance of a cure, and although it involved mutilation, the case was one of life or death, and of immediate urgency, to say nothing of the

state of the arm already referred to. The principle of the method is obvious. We not only secure all the benefits likely to arise from Brasdor's plan, but the removal of the upper extremity, to which the circulation, through the subclavian, is principally directed, removes the attractive force of the tissue to be supplied —the *vis a fronte*, as it has been termed. The function of the affected vessel is arrested, and the circulation, no longer required in that direction, will be thrown upon other vessels. The force of the blood being thus removed from the diseased vessel, and its function being abrogated, I trusted that gradual diminution of the sac, and coagulation within it, would lead to obliteration and cure of the aneurism. In many respects these hopes were realised. The marked diminution, almost effacement of the tumour, which immediately followed the operation, showed, I think, that the force of the circulation through the subclavian was very decidedly lessened, and I think it probable, had it been a saccular aneurism, that coagulation and complete cure would have followed. In this fusiform aneurism, however, all that resulted for some time was flaccidity of the dilated portion, and this permitted re-distension when the circulation became stronger. Ultimately, considerable hardness from coagulation did take place, and the aneurism, though not cured, became small in size, and somewhat consolidated.

There were also peculiar circumstances in this case unfavourable to the desired result. I intended tying the axillary very high up, and accordingly, after securing its cut end, I dissected it upwards; but, a little above the lower border of the lesser pectoral muscle, the vessel dilated so suddenly, and looked so thin in its coats, that I did not venture to tie it higher up than that point. The ligature was higher than the origin of the subscapular, but still a greater number of branches were left between the aneurism and the ligature than I could have wished. Another cause to which I attribute failure was, that owing to the patient's previous habits, stimulants were necessitated from the first, and, as can be easily understood, excited the circulation, and so interfered with the cure. I believe, from the state of the

aneurism when he left Edinburgh, that, had the patient given himself a fair chance, the result might have been more favourable. As it was, whilst the case cannot be considered a cure, the operation was so far successful as to show the correctness of the principle, and to warrant employment of the plan, in any similar case. It certainly prolonged life beyond the time that the ligature of the innominate would have been likely to do. Were I to perform this operation again, I would begin by tying the axillary in its upper third, if healthy, so as to command the circulation, and restrain the terrible hæmorrhage from the dilated collateral vessels.

Popliteal Aneurism.

J. F., iron-moulder, æt. 43, admitted 13th December 1858, stated that about fourteen days previously he first noticed a beating sensation, somewhat painful, in the popliteal space of the leg. At first he paid little attention to it, but as the pain and pulsation steadily increased, he applied at length to the Dispensary, whence he was remitted to the Royal Infirmary on the above date.

On admission, the tumour was about the size of a small orange, and pulsating powerfully. At first the limb was simply placed in the flexed position, and the patient put on low diet and small allowance of fluids. Afterwards compression was superadded, together with the exhibition of small doses of antimony, and this method of treatment continued till the 4th January 1859, without any effect, however, in arresting the progress of the disease. Accordingly, on the 5th January the femoral was tied ; but, owing to the diseased state of the heart and great vessels, no chloroform was administered. Pulse 120. Ordered an opiate.

For a few days after the operation, the patient complained of pain in leg and foot, and slept little ; but on the 10th the restlessness and pain had diminished and the pulse sank to 95.

On the 27th, the ligature came away, and everything was looking well, until 8.30 A.M. the following morning, when hæmorrhage broke out at the point of ligature. About two ounces were lost before the tourniquet could be applied ; and at 11.30 P.M. same evening, and 3 A.M. next morning, about an ounce of blood escaped in all. Ordered wine and an opiate.

30th.—Slept well ; less nervous. Pulse 90.

In the early part of the month of February the patient suffered a good deal from rheumatic pains in various parts of the body, and as the exhibition of opiates was almost imperative, the bowels became somewhat costive. Ordered a powder composed of Chlor. Hydrarg. and Pulv. Rhei āā gr. v. At this time, also, the diet was gradually increased, and on the 17th he was placed on full allowance.

March 12th.—Wound healed. Patient still complains of pain about the ankles and toes, although it is much less severe.

After the above date nothing worthy of remark occurred, and on the 9th May he was dismissed cured.

Recurrence of Popliteal Aneurism after Ligature of Superficial Femoral; Treatment by Compression unsuccessful. Cured by Flexed Position of Leg.

T. H., coal-carter. This patient was first admitted into my wards in May 1857, on account of a popliteal aneurism, which he had only noticed about four weeks previously to his applying for advice. The tumour was then about the size of an orange, its contents fluid, and it pulsated strongly and equally over its whole extent. For some days the patient was kept at perfect rest and on low diet, but the tumour increased so rapidly, and became so tense, that I considered it necessary to tie the superficial femoral without further delay. This was done, and everything went on most favourably. The tumour became flaccid, and ceased to pulsate, and the only cause of anxiety was the low temperature of the foot and leg. The incision healed by the first intention, with the exception of the point where the ligature hung out. The thread separated on the twenty-ninth day after the operation. About the period when the ligature separated, slight undulatory pulsation could be perceived in the tumour, which was much diminished in size ; but as this not unfrequently occurs, I did not pay much attention to it, until the pulsation became gradually more and more powerful ; but even then I was deterred from using any great amount of compression, owing to the low vitality of the foot and the absence of pulsation in the tibial arteries. After a time, however, by bandaging the limb, and cautious compression of the femoral, and direct compression by a compress of lint over the aneurism, the swelling gradually diminished, and the pulsation was reduced to a line corresponding to the course of the artery, and not larger than the popliteal of the opposite limb. After leaving hospital, the patient returned to his usual avocations and habits, occasionally showing himself at the Infirmary. In August 1858, he returned to hospital, and said the swelling had suddenly increased within two or three days. On examination, I found the tumour to be as large, and pulsating as violently, as before the artery had been tied. On consultation with my colleagues, compression was determined on, and a carefully conducted and extended trial of this plan of treatment was given, at first with some promise of success. It was persevered in for upwards of five months, when it was discontinued, as the tumour again began to increase instead of diminish. The patient left the house for some weeks, but returned, desiring to submit to any operation that might be thought necessary. On examining the aneurism at this time, its condition was as follows :—It was the size of a pretty large orange, and pulsating strongly ; the femoral artery could be felt to pulsate for about four inches below Poupart's ligament, ceasing to beat about an inch or less above the point where the superficial femoral had been tied. Pressure on common femoral completely and readily arrested pulsation in the sac. Compression of the superficial femoral above the point tied also did so, but required very firm pressure to be made directly backwards. Compression along the course of the superficial femoral, below the point tied, produced no effect until it was made over the lowest part of Hunter's canal, when the pulsation of the aneurism became thoroughly commanded by it. Under these circumstances, after weighing the

comparative chances of success between ligature of the external iliac, or the lower part of the superficial femoral, the latter plan was decided on, and the patient willingly gave his consent. But as the case did not seem a very hopeful one, it was thought as well to try the plan of flexion of the leg upon the thigh. On bending the limb fully, all pulsation was at once and completely arrested, and the limb was bandaged in that position. But the patient could not bear such flexion to be kept up ; accordingly, a slipper, with a bandage sewed to the heel, was fastened on the foot, and the slip of bandage was then fastened to a loop connected with a broad bandage round his pelvis, and this gradually tightened so as to increase daily the flexion of the leg on the thigh. This treatment was commenced on the 20th of May 1859. On the 23d the pulsations were weaker, but returned when flexion of the limb was discontinued. On the 27th the pulsation diminished ; tumour smaller and firmer. There was still a tendency to increase of pulsation when the limb was allowed to remain straight for any length of time. On the 6th of June the pulsation was scarcely to be felt in the aneurism, even when flexion was discontinued. The tumour felt solid and smaller, and enlarged anastomosing vessels could be felt over it and round the knee. The patient was now allowed to walk about with crutches, the affected limb being suspended in a flexed position. When in bed, or sitting in the ward, he was desired to extend the leg occasionally, and not to keep it constantly bent. On the 23d of June there was not the slightest pulsation to be felt in the aneurism, which was firm, and considerably diminished in bulk. Several very large anastomosing vessels could be felt over the tumour, the limb was of good heat, and there was no stiffness of the knee-joint. I kept the patient for about three weeks longer in hospital under observation, and he was dismissed cured.

Since then he has returned to his usual occupation of a coal-carter, which requires him to walk considerable distances ; but when I last saw him, two years after the operation, there was no tendency to return of the disease.

Remarks.—These two eases of aneurism present some features of interest. In J. F.'s case, the arterial system seemed very generally affeeted, and there was evidence of valvular disease of the heart. When the eommon femoral was eompressed so as to eontrol the eireulation, the eourse of the superfieial femoral eould be readily traeed for some distanee, the rigid state of its eoats maintaining the form of the vessel even when empty. The condition of the patient was therefore by no means favourable ; and from the rigid feel of the artery, I felt apprehensive, lest its eoats might give way under the small round ligature. Still, the rapid inerease of the tumour necessitated the operation to give the patient a ehanee of life, as it was evident that otherwise the aneurism would soon have given way. I therefore tied the

superficial femoral rather lower down than usual, and was well pleased to find its coats perfectly healthy at the part exposed.

As regards the compression, and the other treatment adopted in the first instance, these were had recourse to for the purpose of affording time for a certain amount of coagulum to form in the sac, and not with any prospect of curing the disease, as the unhealthy state of the iliac and common femoral arteries contra-indicated even very moderate direct compression. The bent position employed must not be confounded with the plan adopted in H.'s case. In this case, merely slight flexion over a double-inclined plane of pillows was used, so as somewhat to diminish the direct force of the blood into the aneurism.

The secondary hæmorrhage which occurred seems to me difficult to explain. The ligature did not separate till the twenty-third day after the operation, when the incision had closed except where the thread projected, and there had never been the slightest indication of bleeding, either at the decidence of the ligature or previously. The hæmorrhage, which did not occur till twenty-four hours after the ligature came away, seems to have resulted from incautious exertion of the patient; and when all compresses and dressings were removed, no active bleeding recurred. I have seen bleeding take place at earlier periods after ligature, and not recur; but I do not recollect any instance of the kind in which bleeding came on at so late a date as this, without any premonitory symptoms. Shortly after the bleeding, the parts around the wound looked turgid and brawny, but there was no apparent engorgement of the parts antecedent to or at the time of the hæmorrhage. It seems difficult to believe that it could have proceeded from the deligated point of the artery; for, though the thread had only come away the previous day, it must have separated, and the hæmostatic process caused by it must have been completed, some days before; and if from that source, the bleeding would hardly have been stayed so readily. In my experiments on the ligature of arteries, I have seen two instances in dogs, where, from partial breaking up of the plastic effusion and displacement of the clot, hæmorrhage occurred, and stopped spontaneously;

but it took place in both cases about the tenth day, and resulted from the animals struggling violently with other dogs. From the statement as to the quantity of blood lost, however, it seems in this case either to have proceeded from the superficial femoral itself, or from ulceration of some dilated branch. I have seen the patient several times since he left the hospital; and when I last saw him, he had improved very much in his general health, so as to give me hope that his life may be prolonged for several years, whilst there is scarcely a trace of hardness or swelling at the site of the aneurism—a result satisfactory, as vindicating the operation under such very unfavourable conditions.*

In H.'s case, I attribute the recurrence of the aneurismal condition to the fact that the operation of tying the superficial femoral was performed while the sac was large and its contents so entirely fluid as to admit of the free retrograde circulation into its cavity through the articular branches arising from the diseased part of the vessel. I believe that one condition favourable to success is, that there should be a certain amount of coagulation within the sac before ligature, so as to obstruct or diminish the more direct anastomoses into its cavity, and thereby get rid of a disturbing force and favour consolidation. But in this case I was compelled to operate early during the fluid state, on account of the rapid increase in size of the aneurism, and its threatening to become diffuse. The recurrence of pulsation after it had been so much diminished by pressure and rest, and the sudden enlargement of the aneurismal tumour after remaining quiet so many months (I had seen the man only a week before, and there was then no perceptible change from the state in which he left the hospital), are circumstances not easily explicable. As to the collateral vessel, which seems to have been the principal cause of restoring or keeping up the aneurismal state, I think the effects of compression of the femoral at different parts of its course prove that it must have been the anastomotica magna.

In considering the question of a secondary operation, when

* He died suddenly three years after the operation.

compression failed, the choice was limited to ligature of the external iliac, or of the lower part of the superficial femoral. Under all the circumstances, the former seemed unfavourable, as in all probability the anastomosing branches would be so much enlarged after ligature of the femoral, that the circulation would speedily be restored in the aneurism through the inosculations of the internal iliac with the profunda. Or if, on the contrary, these inosculations were not enlarged, then the risk of gangrene of the limb would be very great; and, had it occurred, amputation, if admissible at all, must have been performed very high up in the thigh, or at the hip. Whilst, on the other hand, the ligature of the superficial femoral low down in Hunter's canal had only one grave objection, that of being near the diseased part. Fortunately, the simpler plan of flexion of the limb prevented the necessity for any operation, and, from what I saw of that plan in this case, I would have great hopes of its success as a curative measure,—far simpler and more efficacious than any form of compression I have seen employed, devoid of all its risks, and not interfering with, but rather beneficial as a preparation for, ligature of the artery, should it fail itself in accomplishing a cure.

Popliteal Aneurism treated by Flexion. Accidental Rupture of Aneurism after it appeared consolidated.

A. N., æt. 36, was admitted on July the 8th, 1862, with an aneurism occupying the lower part of the popliteal space, which, judging from the patient's statements, had probably existed for four months. The patient also suffered from extensive cardiac disease, having a double aortic and a mitral regurgitant murmur, with hypertrophy, especially of the left ventricle. There was general visibility of the pulses, and the radials were slightly corded. Treatment by flexion was adopted, the limb being gently flexed both at the knee and hip joints, and placed on its outer side on an air-pillow. This position was maintained by a strap stretching from the heel of a slipper to a figure-of-eight bandage passed round the thigh and abdomen; while perfect rest was enjoined, with a nourishing but non-stimulant diet. A certain degree of pain, which at first attended this treatment, passed off, and the case seemed to be progressing most favourably, as the tumour had become much smaller and harder, and the articular arteries were distinctly enlarged around the knee. Suddenly, however, on the morning of the 18th August, the patient experienced a sensation as if something had given way behind the knee-joint, and immediately com-

plained of intense pain in the limb. On examination, it was evident that the aneurism had ruptured, and accordingly manual pressure was applied over the femoral artery to prevent further extravasation of blood. After consultation, it was determined to tie the femoral artery, which was accordingly done, the limb being wrapped up in wadding immediately after the operation. On the 16th of August, being the seventh day after the rupture of the aneurism and ligature of the femoral, gangrene of the limb having set in, amputation at the lower third of the thigh was performed by the long anterior flap.

Remarks.—The propriety of tying the femoral artery may be questioned, but, by arresting the circulation, it afforded a reasonable hope that the rent in the sac might become occluded, and the extravasated blood, which was not very large in amount, absorbed; while, even if gangrene did supervene, amputation could be performed before the attending constitutional symptoms had developed themselves.

Case of Fusiform Popliteal Aneurism, cured by ligature of Femoral Artery, after flexion and compression had failed.

Adam B., ætat. 39, a custom-house officer, was recommended to my care by Dr. Struthers of Leith, on account of a peculiar form of popliteal aneurism. The patient stated that his attention had been first directed to the part by pain of a dull aching character, and on putting his hand on it he felt the strong beating, and thereupon consulted Dr. Struthers, who directed him to keep the limb perfectly quiet. After keeping him under observation for a few days, Dr. Struthers sent him to me. This was in April 1866. The swelling in the popliteal space had not the ordinary distinct form of popliteal aneurism, but felt like an enormously dilated artery, becoming smaller above and below. Its contents were quite fluid, and could be easily repressed into the circulation; and when this was done, or when the sac was rendered flaccid by compressing the femoral artery in the groin, the swelling filled again rapidly on pressure being removed. The patient seemed otherwise in good health. The heart's action was normal. The femoral arteries at the groin were not firmer or larger than natural, either in the affected or the sound limb, whilst the radial, ulnar, and brachial arteries were also healthy. He complained chiefly of cramps in the affected leg, and stated that the size and pulsation of the swelling had been increasing of late. The posterior saphena and popliteal veins of that limb were somewhat more dilated than those of the sound limb.

On considering the circumstances of the case, I determined to try the treatment by flexion, combined with graduated compression of the femoral artery in Hunter's canal. With this view I had him kept in bed, and the leg was gradually flexed on the thigh, and the thigh on the pelvis, till he

was able to bear the greatest degree of flexion. At the same time, by means of Signorini's tourniquet, compression was made on the femoral in the situation of the upper part of Hunter's canal; and this also was gradually increased in force until he was able to bear complete obstruction of the circulation for very considerable periods. As he was a very intelligent man, and perfectly understood the principle and object of the treatment, he was instructed how to relax and tighten the instrument, and to note the effect produced. At the end of five weeks the size and pulsatory force of the tumour were so much diminished, as little to exceed those of the healthy vessel; but there was no appearance of solidification or obliteration of the vessel at the affected part. I therefore recommended the treatment to be continued. This was done for three months, when, as the pulsation and size of the vessel felt nearly natural, he was allowed to walk a little, at times resting the limb in the flexed position. At first all seemed to go on satisfactorily, but gradually the vessel dilated, and the pulsation returned in force. Again the treatment by flexion and compression was tried, compression being made both at the groin and also over the artery in Hunter's canal. So long as he remained quiet this treatment produced diminution of the aneurismal swelling, but never seemed to cause any consolidation, the sac apparently being merely rendered flaccid. The patient's health was beginning to suffer from the long confinement, and he was therefore allowed to get up and go out occasionally; and as the swelling soon resumed its original size, and indeed increased in bulk, he determined to submit to the operation of ligature of the femoral.

With this view he entered the Royal Infirmary on the 16th November 1866; and as at that time his general health seemed much deranged, I fortunately determined to wait for a week before operating. In the course of four days the symptoms of typhus fever manifested themselves, and he left the hospital for his own home. He made a good recovery from the fever, and returned to my wards in the infirmary on the 18th of January 1867, much improved in health, but the aneurism considerably increased in size.

On the 23d January I tied the femoral artery at the lower part of Scarpa's triangle. The operation was very easily accomplished, as there was scarcely any oozing of blood. The coats of the femoral were beautifully healthy, and the aneurism needle very easily passed without disturbance of the parts. The only thing noticeable was the great depth of the vessel from the surface, owing to a large amount of fat, both superficial to the sartorius and between the fascia and the sheath of the vessels, a condition remarkable in a patient so recently recovered from typhus fever.

The wound was dressed in the usual manner. Nothing of importance occurred in the after progress of the case. The ligature separated on the 11th of February, and he was dismissed cured on the 6th of March 1867. When I last heard of him he continued in perfect health, and free from any aneurismal disease.

Remarks.—In accordance with the views, and for the reasons I have stated in my lectures, I believe that the fusiform or ovoid

aneurisms arising, as they do, from dilatation of all the coats of the artery, are less favourable for curative treatment of any kind than the lateral or sacculated aneurism, as the tendency to coagulation is much less. The reasons which induced me to give so prolonged a trial to flexion and compression in B—'s case were—1st. Because I was afraid that, as the aneurismal portion contained no coagulum, the free inosculations of the branches of the profunda femoris, with the articular and other branches arising from the dilated popliteal, would almost directly restore the circulation in the aneurismal portion immediately after ligature of the superficial femoral, and so prevent a cure. 2dly. Because I trusted that, if I did not accomplish a cure, by the flexion combined with compression, this treatment would at least conduce to some coagulation or deposit of fibrine taking place within the aneurism, and so prepare for the ligature of the artery being attended with a greater chance of success. The combination of compression with the flexion method obviated the risk of any accidental rupture of the aneurism occurring, as in the case of A— N—.

Case of Femoral Aneurism successfully treated by Ligature of the Femoral Artery in Scarpa's Triangle.

W. W., æt. 32, labourer, admitted Jan. 4. About four months ago, patient observed on the inner aspect of his right thigh, a firm, throbbing swelling, of the size of a walnut. Origin spontaneous, and increase gradual. On admission, an aneurism as large as a small apple was found at the upper entrance of Hunter's canal.* On compressing the femoral artery, pulsation ceased, but the tumour could not be completely emptied of its contents. Ordered rest, and milk diet.

Jan. 10.—Professor Spence tied the superficial femoral artery in Scarpa's triangle, which produced immediate cessation of pulsation. The limb was kept slightly flexed, and enveloped in wadding. Convalescence progressed uninterruptedly, and the ligature separated on the tenth day after the operation. Patient dismissed cured, after having been two months in hospital; the tumour was hard, painless, and not larger than half a walnut.

The femoral aneurism is a form not commonly met with. According to Dr. Crisp, "of 551 cases of aneurism, 157 affected

* See Plate xxvi. Fig. 1.

the popliteal, and only 66 the femoral artery; and of these 66, only 21 were truly femoral or femoro-popliteal." This may be accounted for by the exposed position of the artery in Scarpa's triangle and in the popliteal space, allowing for expansion at these points; while, in the intermediate part, the vessel is surrounded by muscles and aponeurosis. The most frequently employed modes of treating such cases are compression, or ligature of the superficial femoral or external iliac arteries. The former of these methods is uncertain and tedious, while the latter is attended with great success. In the case of W. W., not a single bad symptom followed the operation, and a very small amount of suppuration served to cause separation of the ligature. On his being dismissed from hospital, the tumour was firm, painless, and less than half its original size. The patient walked about without experiencing any inconvenience; and when heard of, about six months later, he was able to work as formerly, and the tumour continued to diminish.

Traumatic Varicose Femoral Aneurism successfully treated by Double Ligature.

On Thursday, 26th March 1868, I was requested by Mr. Miller, surgeon, Rankeillor Street, to visit Robert K——, a youth who had received a wound in the thigh about three weeks previously. Accordingly I met Mr. Miller and Dr. Littlejohn in consultation. Mr. Miller, who had been called to the lad immediately after the injury, gave me the following account :—

"I was hastily called by the police to the shop of Mr. Prentice, druggist, 126 Nicolson Street, on the afternoon of Wednesday, 4th inst. (March 1868), to see Robert K——, aged fifteen years, of Graham Street, who had been stabbed with a spear-pointed knife by a school-fellow. Supported by a man he had walked from Buccleuch Street, and had fainted by the way from loss of blood. I found him lying on two chairs, very pale and faint, in consequence of profuse hæmorrhage issuing from a wound in the upper and anterior aspect of the right thigh. The wound, which extended obliquely upwards, was about three-quarters of an inch in length, and one inch and a half in depth. After stopping the hæmorrhage and dressing the wound, I had him conveyed home in a cab. He progressed very favourably, and in ten days the wound had entirely healed, though the patient still continued weak. Perfect rest was still enjoined, but after a few days he could not be restrained from going out and walking about, though rendered lame by slight pain and stiffness of the

tendons at the back of the limb, which, however, improved every day. He called on me on Monday, 23d inst., and stated that he had been to Leith on the previous Friday, that he had walked hurriedly home from the station, and for the first time felt 'a beating' in the part, but no pain. On examination, a little above the wound, I found a pulsating tumour, which I diagnosed as a false aneurism. He was ordered home, and enjoined perfect rest and quietness."

I found the patient a lad of slender form, and tall for his age, of delicate appearance, and somewhat anæmic. On examining the right thigh, I observed a cicatrix as of a recent punctured wound, situated on the outer border of the sartorious muscle, five inches and eight lines below the middle of Poupart's ligament. Extending from the puncture there was a pulsating swelling, not very prominent, somewhat flattened, of an elongated oval form, two and a half inches long, by one and three-quarter inches broad. About two inches of the swelling were on the proximal side of the wound, *i.e.* towards Poupart's ligament, and about half-an-inch on the distal side. Besides this distinct pulsating tumour, there was also an undefined fulness on the inside of thigh, close up to Poupart's ligament, caused by the dilated femoral vein, and the upper part of internal saphena was also dilated. The aneurismal swelling at the wound was seen to pulsate, and the pulsation was very strong when the hand was placed on the tumour, and accompanied by a most peculiar thrill, almost startling, when first felt. On using the stethoscope, besides the "blowing" sound, there was also heard a loud buzzing or whizzing *bruit*, which has been not inaptly compared to the noise made by a "blue-bottle fly confined in a paper bag." This latter sound was so loud as to be heard even at a little distance, and without the stethoscope. The thrill and whizzing murmur extended upwards from the wound both in the aneurismal tumour, and in the dilated femoral vein nearly as high as Poupart's ligament, but they were much less distinct in the lower part of the aneurism—only barely appreciable. The pulsations of the anterior and posterior tibial arteries seemed rather weaker than in the sound leg. The patient felt the limb somewhat cold, but the thermometer showed no difference in the actual temperature.

I directed that he should be kept perfectly quiet in bed, with the thigh flexed on the pelvis, and that graduated compression should be maintained upon the common femoral artery, at the brim of the pubes, where it emerges from the abdomen, by Carte's compressor, modified so that the pressure was made by means of a leaden weight instead of the full screw action. He was ordered to have a nutrient, non-stimulating diet, consisting of milk, with white of eggs, and farinaceous and a little animal food. Under this treatment the pulsations and bulk of the aneurism diminished, but I found that the compression, though as far as possible limited to the artery, interfered with the venous circulation, and gave rise to so much pain and swelling in the thigh, and irritation of the inguinal glands, that it was obliged to be abandoned. Ice was then applied over the swelling and to the groin, and was beneficial in allaying the irritation resulting from the compression, but it had little effect on the aneurism; and I therefore determined to operate so soon as the local irritation was subdued. I had from the first contemplated the probability

of an operation being required, and had carefully weighed in my mind what method of procedure I should adopt, and had decided, for reasons which I shall explain hereafter, to tie the superficial femoral above and below the aneurism without opening the sac. Accordingly, on the 8th of April 1868, assisted by Drs. Dunsmure, Gillespie, Littlejohn, Taylor, and Mr. Miller, I proceeded to perform the operation I had planned. The patient being put under the influence of chloroform, I made an incision $7\frac{1}{2}$ inches long, commencing about 2 inches below the middle of Poupart's ligament, and continuing downwards in the course of the femoral artery. This incision passed over the long axis of the aneurism, and crossed the course of the sartorius muscle, so that I might reach the artery under the inner border of that muscle at the upper part, and under its outer margin at the lower part of the thigh. In making my incision I was careful to cut lightly over the tumour, so as not to divide more than the skin and fat. I next proceeded to clear the artery in the lower part of Scarpa's triangle. In doing so I found the parts more matted together and thickened, and the depth increased from the plastic and serous effusion to a much greater extent than the external appearances would have led me to expect. I required to take great care in clearing and drawing aside the inner edge of the sartorius, which, instead of being loosely connected as usual, was adherent. The sheath of the artery, however, was not so affected, and was readily recognised and carefully opened, and the artery cleared for passing the aneurism-needle. The vein, much distended, was felt bulging under the artery. The armed needle was then carefully passed round the vessel, the ligature left *untied*, and the ends held by an assistant. I next proceeded to tie the femoral below the aneurism in Hunter's canal. The fascia over the outer edge of the sartorius was freely divided, and the edge of the muscle cleared. Here a difficulty occurred, not from adhesion of the margin of the muscle at the part cleared, but owing to the body of the muscle over the aneurism being blended with the tumour, and forming part of the false sac. I found I could not turn over the muscle or draw it aside, so as to expose the aponeurosis covering the artery, without using such force as would have endangered breaking up the limitation of the aneurism. I had, however, foreseen this difficulty, and accordingly, as I wished to tie the artery as close as I could to the aneurismal tumour, I divided about half the breadth of the sartorius, so as to expose and reach the vessel, which here lay very deeply, the depth being increased by the proximity of the tumour. When I had passed this ligature, I tied it firmly, and then proceeded to tie the upper ligature, which had also been applied as closely as possible to the swelling. So soon as the upper ligature was tightened, all pulsation and sound ceased, and the appearance of tumour was almost effaced. The long wound was then closed by points of suture, a slip of dry lint placed over it, and retained by slips of adhesive plaster ; the foot, leg, and knee were wrapped in cotton wadding, and the patient placed in bed, with the knee very slightly bent, and laid on its outside on a soft pillow.

When the patient recovered from the chloroform he was a little sick, and vomited. An opiate was administered. The milk and farinaceous diet were ordered to be continued. He progressed very favourably, and the wound healed well, little treatment having been required, except medicine

and enemata to act on the bowels—which were very constipated—so as to prevent straining at stool. No marked alteration in the temperature of the limb occurred after the first two days. On the twelfth day after the operation, the lower ligature came away when I was dressing the wound, and without any appearance of blood. Slightly stimulating lotions were used to wash the points of the wound which had not cicatrised, and support was given by strips of adhesive plaster. On the 25th of April I had to leave for London, and I visited him on that day (the eighteenth after the operation). He was looking well and cheerful ; pulse 86, and soft, and his tongue clean.. The wound looked well—in fact, except where the upper ligature hung out, and at one or two other points, it had united ; and I considered him almost, if not altogether, out of danger. I left Dr. Dunsmure, who took charge of my cases, to look after him as regarded the surgical treatment. From that gentleman I received a letter, informing me of a somewhat unexpected and sudden change in the progress of the case :—

"You left on Saturday the 25th. On Sunday I got a note saying that after straining at stool, four drachms of blood had come from the incision. On visiting him I found no trace of hæmorrhage at either of the ligatures, but the wound had opened over the sac, and a clot of blood was lying in it ; his pulse was quick, 120, and his skin hot. Mr. Miller had ordered him aconite, which made him sick. All that I did was to enjoin quiet, and cold to the wound ; and, as his tongue was loaded, I ordered him a blue and compound rhubard pill. On Friday, when I saw him with Mr. Miller, he looked more than usually pale, and his pulse was still quick, but the skin and tongue were better. He had had pain in the right side, and some cough, both of which were relieved by a poultice. I ordered him a better diet, wine (claret), and iron, and to-day his pulse is 96 ; the wound is almost healed, the part over the sac is healthy, and I have no fear of him. I took hold of the ligature, but it is not yet sufficiently loose to come away."

After this the bad symptoms seem to have disappeared, and, on my return to Edinburgh on the 11th May, I found him looking very well, the wound healed, except at the ligature, which I found was lying loose, and I therefore removed it. From this time nothing worthy of record occurred. He was allowed to walk at first with a crutch, and subsequently to use the limb. He was lame for some time owing to the stiffness of the knee, but this gradually disappeared, and he now uses the leg perfectly. For some time after the operation I directed him to use a flannel roller to support the venous circulation in the limb. The cicatrix was narrow and firm ; not the slightest pulsation or *bruit* to be felt or heard, no appreciable venous congestion, and his general health excellent.

To-day (10th June 1869) I examined Mr. K——. As already stated, the aneurism is thoroughly cured ; not the slightest pulsation or thrill can be felt ; but the appearance of the limb indicates some obstruction or alteration in the venous circulation of the part. The right thigh is greater in circumference by one inch than the left. The swelling is neither tense nor œdematous, but soft and elastic. The cicatrix is thinner and broader than it was eight months ago ; whilst towards the groin numerous small superficial veins are seen dilated and slightly tortuous ;

but the common femoral and great saphena veins, which were distended and varicose before the operation, seem now of their normal size. (Plate xxv. Fig. 3.)

Remarks.—Numerous observations have been recorded in reference to the pathology and treatment of varicose aneurisms, but, with few exceptions, these have been cases in which the disease was situated at the bend of the arm, and in most of them the operative procedure has been the same as that for ordinary false aneurism in the same position—namely, laying open the sac and tying the wounded artery above and below the opening; and in some of the cases ligature of the affected vein has also been practised.

In one or two cases the brachial at the middle of the arm has been tied, but not with results that encourage repetition of the Hunterian method. Indeed, in the upper extremity the ligature of the wounded brachial artery above and below the opening, and gentle compression of the injured vein, answers sufficiently well, and the operation is not likely to be attended with bad results. It is, however, very different with regard to such aneurisms in the femoral region.

All surgical authorities are agreed as to the great danger which attends obstruction of the femoral artery when complicated with any lesion of the accompanying vein, gangrene being the almost invariable result. So much have the risks of such a complication influenced practice, that even in cases of ordinary traumatic false aneurism of the femoral, in the position of Hunter's canal, an exception has been made to the general rule of operating in false aneurism by direct incision into the sac. Thus, in cases where the traumatic aneurism is of some standing, and the parts condensed, it is considered better, in the case of the femoral artery, to tie the vessel by the Hunterian method in Scarpa's triangle, lest, from the close proximity of the vein and the condensation and matting of the wounded parts, the latter vessel might be injured in operating by the direct method; and Professor Syme and others have recorded cases showing the success of such treatment.

In considering what method of operation I should follow in the case of K——, I could find but little information in surgical works as to the treatment of traumatic varicose aneurism of the femoral, either as regarded general principles or the results of actual practice. As I have already said, most of the observations of Hunter, Park, Hodgson, Breschet, Sabatier, and Dupuytren, had reference to varicose aneurisms at the bend of the arm, and the general rule laid down, as drawn from such cases, was to open the sac and tie the vessel as in false aneurism—a rule repeated, I see, in the last edition of Professor Erichsen's "Surgery," as applicable to varicose aneurisms generally.

The only author who differs from this practice is the late Mr. Lizars, who, speaking of this form of aneurism at the elbow, advises tying the artery above and below the wounded point without opening the sac. His reason is, the risk of phlebitis, if we interfere with the vein ; and I recollect seeing him perform this operation in a small varicose aneurism of the brachial in the Royal Infirmary. At the bend of the arm, however, the results of the ordinary operation have shown that the risk Mr. Lizars dreaded was so slight that his plan has not been generally followed.

In looking to the history of cases of this aneurism in the thigh, I could find very few cases recorded, still fewer where any operation had been performed. Several of the cases which had done well without treatment were evidently cases of aneurismal varix, and not of varicose aneurism. It is essential to remember, in reference to treatment, that whatever symptoms these two diseases may have in common, such as the peculiar *bruit* the state of the veins in the affected limb, or the constitutional effects consequent on admixture of venous with arterial blood, they differ in this important feature, that in aneurismal varix we have the vein and artery closely adherent and communicating directly, and that, although both vessels undergo dilatation and some alteration in structure and function, there is no aneurismal tumour involving the risks incident to all aneurisms, and consequently in it all that is generally re-

quired is moderate support to the venous circulation by bandages or elastic or laced stockings. In varicose aneurism, on the contrary, the false sac, which communicates with both vein and artery, has a constant tendency to increase, burst, and diffuse its contents into the limb, or else lead to ulceration of the skin and fatal hæmorrhage.

The records of traumatic varicose aneurism of the femoral or popliteal are very meagre. I can find only two cases detailed, and one doubtfully alluded to by Sabatier. Both the detailed cases were in the popliteal artery. One case occurred under M. Larrey, Director of the Military Medical School at Toulouse, and uncle of Baron Larrey. In that case amputation was performed. In the other case, under the care of Dr. Dorsey of Philadelphia, the disease followed a gunshot wound. The femoral artery was tied in the middle of the thigh, and hæmorrhage supervened and destroyed the patient Mr. Hodgson, in his work on the blood-vessels, suggests that ligature of the femoral in Scarpa's triangle would be the proper plan of treatment. The diminution of the force of the blood after the ligature, he thinks, would favour the formation of a coagulum, which would finish by filling up the sac, and obliterate its opening of communication with the vein; but he adds, "I do not think, however, that any one has yet tried this operation."

Since operating on the lad K——, I have learned from Mr. Paget that Mr. Lawrence operated by Hunter's method in a case of varicose aneurism of the thigh; but gangrene came on, amputation was found to be necessary, and the patient died. There is a brief notice of the case in the Catalogue of the Museum of St. Bartholomew's Hospital, vol. ii., Description of Casts; but there are no details given.

In deciding on the method I should adopt, when I found that compression could not be continued with any hope of success, it appeared to me that I could scarcely trust to ligature of the superficial femoral in Scarpa's triangle; for, though I believe that to be the safest procedure in certain cases of simple traumatic aneurism in the thigh, the conditions are very different in

the varicose. In a simple traumatic aneurism of the femoral artery in the middle region of the thigh, where some time has elapsed after the injury, the dense aponeurotic structures, confining the wounded vessel and extravasated blood in a narrow space, assisted by the condensation of the surrounding cellular tissue resulting from plastic effusion, serve to form an amount of limitation and circumscription almost equal to the sac of a true aneurism, and to favour consolidation of the blood-clot ; so that when the force of the direct blood-current is shut off, gradual consolidation and obliteration take place, as in cases of true aneurism. In traumatic varicose or arterio-venous aneurism, on the other hand, whilst we may have similar limitation as regards the surrounding parts, we must keep in mind that through the interior of the sac there is a communication more or less free with the large femoral vein ; so that the retrograde current of blood will meet with no resistance in that direction. Complete consolidation of the contents of the sac could scarcely be looked for, and as the collateral circulation enlarged, the retrograde current would become stronger, and in all probability the diseased condition would be re-established.

The plan generally adopted in varicose aneurisms at the bend of the arm I have already indicated as being inapplicable in the thigh ; for if surgeons avoid operating in the usual manner for ordinary traumatic aneurisms of the femoral, from dread of injury to the vein, what is only a risk in that case becomes a certainty in varicose aneurism ; because in it the artery and vein already communicate in the sac ; opening the sac, therefore, implies more or less interference with the vein, and would be followed by the usual bad results. Careful consideration of these circumstances induced me to adopt the plan of tying the femoral artery above and below the sac, in such a manner as to avoid opening or injuring it, by the operative procedure which I have described in the case. By doing so, I trusted that all retrograde arterial circulation would be obviated, that coagulation of the contents of the sac would take place, and that the wound of the vein communicating with the sac would thus be closed, and the

venous circulation restored to its natural channel. So far as the artery is concerned, my expectations have been fulfilled, and the aneurism is thoroughly cured; but judging from the present appearance of the limb, some slight obstruction to the venous circulation would seem to exist, and, though not productive of any inconvenience at present, will require to be remedied by the use of an elastic stocking to support the returning column of blood, and so avoid any tendency to varix.

From a full consideration of the general principles on which the method of operating which I have described is founded, as well as from the successful result of the case narrated, I feel satisfied that it is the proper mode of procedure in cases of varicose aneurism.

In closing, I would merely advert to the sudden and unexpected invasion of peculiar and serious constitutional symptoms so late as the nineteenth day. I do not pretend to speak decidedly, but my first impression when I received Dr. Dunsmure's letter was, that some small detached portion of the contents of the sac had found its way into the vein, and given rise to thrombosis, although the favourable termination of the symptoms scarcely warrant that idea; and, possibly, it was mere febrile disturbance, due to some irregularity in diet.